Ballville Dam Project,
Sandusky County, Ohio

FINAL
Supplemental Environmental Impact Statement

Prepared by
U.S. Fish and Wildlife Service
Midwest Region Regional Office - Fisheries
5600 American Boulevard West
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a.	Title:	Ballville Dam Project, Sandusky County, Ohio
b.	Subject:	Final Supplemental Environmental Impact Statement (SEIS)
c.	Lead Agency:	United States Fish and Wildlife Service

d. Abstract:

Ballville Dam is currently a complete barrier to upstream fish passage and impedes hydrologic processes. The purpose for the issuance of federal funds and preparation of this Final SEIS are to restore natural hydrological processes over a 40-mile stretch of the Sandusky River, re-open fish passage to 22 miles of new habitat, restore flow conditions for fish access to new habitat above the impoundment, and improve overall conditions for native fish communities in the Sandusky River system both upstream and downstream of the Ballville Dam, restoring self-sustaining fish resources.

On October 21, 2011, The U.S. Fish and Wildlife Service published a notice of intent to prepare a Draft EIS and request for comments in the Federal Register (FR 76 65526). The comment period for this notice ended on November 21, 2011.

On January 24, 2014, the U.S. Fish and Wildlife Service published the Notice of Availability of the Draft EIS in the Federal Register (FR 79 4354), opening a 60 day public comment period.

On August 1, 2014, the Service issued the FEIS in the Federal Register (FR 79 44856) opening a 30-day comment period. The public comments and associated responses were summarized in Appendix B2 of the FEIS. The Service then provided a concise record of its consideration of the environmental analysis in the Record of Decision (ROD) for the project, which was signed on October 2, 2014.

On February 26, 2016, the U.S. Fish and Wildlife Service published the Notice of Availability of the Draft SEIS in the Federal Register (FR 81 9877), opening a 45 day public comment period. Comments were received from individuals, organizations, and agencies, addressing a number of topics. Public comments and responses are available in Appendix B of this Final SEIS.

This Final SEIS is a limited scope document that builds on the previous environmental documents compiled for this project, incorporating new information regarding contaminant analysis of sediments within the Ballville Dam Impoundment. It also addresses other sediment related questions and concerns to ensure as complete an understanding and incorporation of concerns relating to sediment into the decision making process.

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f.	Transmittal:	This Final Supplemental Environmental Impact Statement, prepared by the U.S. Fish and Wildlife Service Staff is being made available to the public in October 2016. We request comments from the public on the Final SEIS and related documents, which are available at the locations specified below. We will accept comments received or postmarked within 30 days of publication of the notice of the Final SEIS in the Federal Register. Comments must be received by 11:59 p.m. Eastern Time on the closing date. The U.S. Fish and Wildlife Service's decision on issuance of Federal funding will occur no sooner than 30 days after the publication of the Environmental Protection Agency's notice of the Final EIS in the Federal Register and will be documented in a Supplemental ROD. You may obtain copies of the Final EIS and related documents on the Internet at: http://www.fws.gov/midwest/fisheries/ballville-dam.html You may obtain the documents by mail from the Fisheries Office in the Midwest Regional Office (see contact information above). To view hard copies of the documents in person, go to the Birchard Public Library during normal business hours; 423 Croghan Street, Fremont, Ohio 43420, (419) 334-7101.

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1.0 PURPOSE AND NEED FOR ACTION

1.1 INTRODUCTION

This Draft Supplemental Environmental Impact Statement (SEIS) has been prepared by the U.S. Fish and Wildlife Service (Service), the lead agency, pursuant to the National Environmental Policy Act (NEPA) (42 U.S.C. §4321 et seq.). The Service has worked with the City of Fremont (City), Ohio Department of Natural Resources (ODNR), and the United States Army Corps of Engineers (USACE), and other partners to gather pertinent information in the preparation of the Final SEIS to ensure it is as complete as possible.

The federal action under consideration is the use of federal funding for removal of the Ballville Dam. The purpose of this Final SEIS is to supplement the Final EIS (FEIS), which evaluated and explained the environmental effects of federal actions to decision-makers and the public while ensuring that comments from the public were considered and integrated to the greatest extent practical. The FEIS described and evaluated alternatives to achieve the purpose of the project, including alternative methods of providing fish passage upstream and downstream of the Ballville Dam location, restoring natural hydrologic and sediment transport regimes, and addressing dam safety and liability.

The Service has an agreement with ODNR to fund the project under the Great Lakes Restoration Initiative (GLRI) through the Great Lakes Fish and Wildlife Restoration Act (GLFWRA) (16 U.S.C. 941 §4321 et seq.) pursuant to NEPA compliance. The GLRI is a driver for environmental action in the Great Lakes. Building upon strategic recommendations for how to improve the Great Lakes ecosystem presented in the Great Lakes Regional Collaboration Strategy of 2005. GLRI represents a collaborative effort on behalf of the U.S. Environmental Protection Agency and 15 other federal agencies, including the Service, to address the most significant environmental concerns of the Great Lakes.

The GLFWRA authorizes the Service to work in partnership with States, Tribes, and other Federal agencies to develop and implement proposals for the restoration of fish and wildlife resources in the Great Lakes Basin and to provide assistance to Great Lakes fish and wildlife agencies to encourage cooperative conservation, restoration, and management of the fish and wildlife resources and their habitats. Fish and wildlife restoration projects are selected through a competitive review process from proposals submitted by States, Tribes, and other interested entities. Projects have focused on restoring wetlands; restoring aquatic habitat; fish community research and assessment; developing ecosystem management tools; and ecological monitoring and modeling.

The Ballville Dam Project proposal was submitted for consideration by the ODNR. The proposal was selected for funding after undergoing a competitive rigorous review through pre- and full proposal stages as well as independent anonymous peer review and comment. It was among 10, out of an initial 165 pre-proposals and 41 full proposals to receive funding through the

GLFWRA on August 12, 2010. This funding would be utilized by ODNR, and through a sub-agreement, the City to directly carry out the project.

Additionally, the GLRI is the largest investment in the Great Lakes in two decades. In 2010, a task force of 16 federal agencies and many of the region's governors released the GLRI Action Plan covering five urgent issues called focus areas:

- Cleaning up toxics and areas of concern;
- Combating invasive species;
- Promoting near shore health by protecting watersheds from polluted run-off;
- Restoring wetlands and other habitats; and
- Tracking progress, education and working with strategic partners.

The Ballville Dam project, funded with GLRI resources, would help to address the restoration of the Great Lakes through aquatic habitat restoration in the Sandusky River.

1.2 National Environmental Policy Act

The NEPA is a federal law that establishes a national environmental policy and provides a framework for planning and decision making by federal agencies. Specifically, NEPA requires that federal agencies integrate an interdisciplinary environmental review process that evaluates a range of alternatives, including the No Action Alternative, as part of the decision-making process. The purpose of NEPA is to ensure that the potential environmental impacts of any proposed federal action are fully considered and made available for the public to review. This process also establishes a need to include interagency coordination and public participation in the process. In summary, NEPA is intended to promote public participation and inform decision making by federal governmental agencies.

The Council on Environmental Quality (CEQ) was established under NEPA for the purpose of implementing and overseeing federal policies as they relate to this process.

Issuance of funding under the GLFWRA constitutes a discretionary federal action by the Service and is thus subject to NEPA. Due to the expectation of federal funds administered by the Service for use in removal of Ballville Dam, the Service is the lead Federal agency for the SEIS. Cooperating Agencies on the EIS included the City, Ballville Township Trustees, ODNR, and USACE.

In 1978 the CEQ issued Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (40 C.F.R. parts 1500-1508). Section 102(2) (C) of NEPA mandates that the lead federal agency must prepare a detailed statement (commonly called an Environmental Impact Statement [EIS]) for legislation and other major federal actions that significantly affect the quality of the human environment. Such projects include any actions under the jurisdiction of the federal government or subject to federal permits; actions requiring partial or complete federal funding; actions on federal lands or affecting federal facilities; continuing federal actions with effects on land or facilities; and new or revised federal rules, regulations, plans or procedures. Any action with the potential for significant impacts to the human environment requires the preparation of an EIS. Otherwise, an environmental assessment and finding of no significant impacts (FONSI) may be prepared under Section 102(2) (E) of NEPA. Additionally, Agencies shall prepare an SEIS if the agency makes substantial changes in the proposed action that are relevant to environmental concerns; or there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts.

On October 21, 2011, the service issued a Notice of Intent to prepare an EIS to evaluate the impacts of the proposed Ballville Dam Project in the Federal Register (FR 76 65526). The Service, along with the Cooperating Agencies, used the comments provided in that scoping period to develop alternatives discussed in the EIS and identify primary concerns relating to the Ballville Dam EIS.

On January 24, 2014, the Environmental Protection Agency published the Notice of Availability of the Draft EIS (DEIS) in the Federal Register (FR 79 4354), opening a 60 day public comment period. Comments were received from 29 individuals, organizations, and agencies, addressing a number of topics.

On August 1, 2014, the Service issued the FEIS in the Federal Register (FR 79 44856) opening a 30-day comment period. The public comments and associated responses were summarized in Appendix B2 of the FEIS. The Service then provided a concise record of its consideration of the environmental analysis in the Record of Decision (ROD) for the project, which was signed on October 2, 2014.

On February 26, 2016, the U.S. Fish and Wildlife Service published the Notice of Availability of the Draft SEIS in the Federal Register (FR 81 9877), opening a 45 day public comment period. Comments were received from individuals, organizations, and agencies, addressing a number of topics. Public comments and responses are available in Appendix B1 and Appendix B2 of this Final SEIS.

The Service has prepared this Final SEIS in accordance with NEPA and is issuing it for a 30 day public comment period. After consideration of the public comments received, the Service will issue a concise record of its consideration of the environmental analysis in a supplement to the ROD. To date, no irreversible or irretrievable loss of resources associated with the Project has occurred. Further, the Service will not approve any proposal that would result in irreversible or irretrievable loss of resources prior to publication of the Supplemental ROD.

1.2.1 Focus of Supplemental EIS

This Final SEIS is a limited scope document that builds on the previous environmental documents compiled for this project, incorporating new information regarding contaminant analysis of sediments within the Ballville Dam Impoundment. It will also address other sediment related questions and concerns brought forth during the interim period between the publication of the ROD in October 2014 and the present to ensure as complete an understanding and incorporation of concerns relating to sediment into the decision making process.

As part of the supplemental review process, the FEIS was reviewed in the context of the new information. The majority of the analyses in the FEIS did not warrant supplementation due to the new information. However, the interdisciplinary team determined the need to supplement portions regarding sediment quality within the impoundment.

Specific sections of the FEIS that are most essential to the Final SEIS and those sections that are supplemented by new information in the Final SEIS are directly incorporated here. All other sections are part of the entire analysis and decision and are incorporated by reference herein.

1.3 PROJECT BACKGROUND

1.3.1 Background of Dams near the City of Fremont and Ballville Township

1.3.1.1 Tucker Dam and Creager Dam

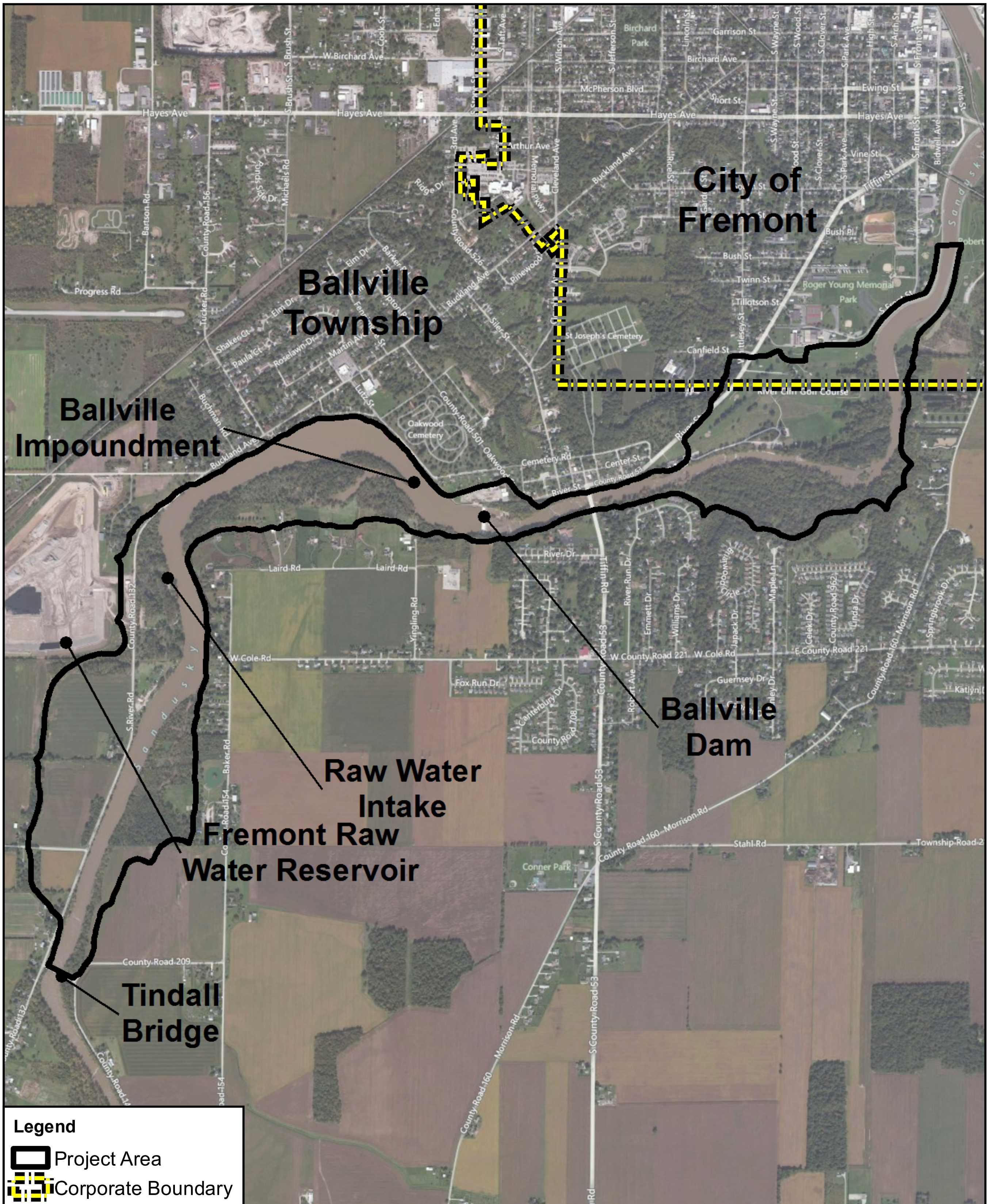
Numerous dams have been located over time both upstream and downstream of Ballville Dam (ASC 2011). The Tucker Dam was reportedly built between 1835 and 1858 and was a nine foot tall timber crib design that used water power to work a flour grist-mill. This dam and mill was reported to be operational into the early 1900's and was located within the current Ballville Dam impoundment. Bathymetric surveys conducted in 2011 in the Ballville impoundment detected the likely abutment of the old Tucker Mill upstream of the Ballville Dam but no other associated material (Stantec 2011). The potential abutment remnants are located approximately eight feet below normal pool level of the impoundment. Further survey effort in 2013 by the ODNR also identified what appeared to be a concrete abutment in this vicinity, but no other discernible material was seen (FEIS Appendix A1).

The Creager Mill Dam was located downstream of the Ballville Dam. Little information is available on this dam. This dam was operational in the early 1800's and powered various wool works mills. It is believed that this dam was swept away by "great ice gorges occurring with floods" (Meek 1909). Its exact location is not known and no evidence (i.e. abutments, mill house, foundations) are in existence today.

1.3.1.2 Ballville Dam

The Ballville Dam was built on the Sandusky River between 1911 and 1913 in Ballville Township, approximately 1.5 miles (2.4 kilometers) upstream of the City and approximately 18 river miles (29 kilometers) upstream of Lake Erie (Figure 1-1). The dam is approximately 407 feet (124.1 meters) long and 34.4 feet (10.5 meters) high. It is composed of left and right spillways on either side of a non-overflow section. The right spillway, facing downstream, is 228 feet (69.5 meters) in length and has a crest elevation of 623.2 feet (189.9 meters) above sea level, the left spillway is 86.5 feet (26.4 meters) long and has a crest elevation of 624.2 feet (190.3 meters) above sea level, and the non-overflow is 92.5 feet (28.2 meters) long with a crest elevation of 633.8 feet (193.2 meters) above sea level. The non-overflow section has a penstock, six sluice gates, and a water intake. Additionally, a concrete sea wall, with a top width of 1.5 feet (0.5 meters) and top elevation of 636.7 feet (194.1 meters) above mean sea level, extends approximately 702 feet (214 meters) upstream from the left abutment.

The impounded section of the Sandusky River extends upstream from the dam approximately 2.1 miles (3.4 kilometers) and the surface area is approximately 89.3 acres (36.1 hectares) (ODNR 1981). Various private residences are located with views of the impoundment in several locations (Figure 1-1). The City's new raw water intake is located approximately 6,000 feet (1,828.8 meters) upstream of the dam and the new raw water reservoir is to the west of the intake. This reservoir became operational in February 2013. The upper extent of the impoundment is located near the Tindall Bridge where Rice Road crosses the Sandusky River.



Basemap: BING

Ballville Dam Project Area

Ballville Dam Project

0 1,000 2,000 Feet

Figure 1-1

The dam was originally built as a run-of-the-river hydroelectric generation facility by the Fremont Power and Light Company, which later became the Ohio Power Company. Run of the river designs provide limited water storage, while passing water freely over the dam in proportion to the quantity being delivered to the impoundment. This design functions to provide a constant pool for water withdrawal, not control of output. The dam was abandoned as a hydroelectric facility in the early 1900's because seasonal flow in the river was insufficient to meet power generating requirements of the plant. The company built a steam power plant to supplement the output of the hydroelectric plant in 1916. The steam power plant closed in 1929 but was reactivated briefly during World War II to supplement the region's power supply. The steam power plant was demolished in 1954.

The City bought the land and facilities in 1959 and re-purposed the dam to provide the City's water supply. Since the purchase of the Ballville Dam by the City in 1959, the impounded area has been used as a source of public water. In February 2008, the Ohio Environmental Protection Agency (OEPA) issued a Findings and Orders notification to the City citing numerous Ohio Administrative Code (OAC) Rule violations related to the operation of the Public Water System (PWS) and water quality of the City's PWS (OEPA 2008b). Among the violations were elevated nitrate levels[1] documented from samples taken over a period from June 1999 to June 2007. Within the Findings and Orders, the OEPA ordered the City to prepare plans for construction of an off-stream reservoir that would hold approximately 730 million gallons of raw water to address the nitrate violations. A schedule was also provided for completion of construction plans and start of operation of the water supply (OEPA 2008b). In August 2011, the OEPA revised the original Findings and Orders to include violations of the previously agreed-upon schedule. The new Findings and Orders provided a new schedule based upon the expected date of operation for the raw water reservoir system (OEPA 2011b). This document also noted continued nitrate level violations during the periods of 2009 and 2010. The reservoir became operational in February 2013. As of fall 2013, the new raw water reservoir is the primary source of water for the City of Fremont and has an available water capacity of 730 million gallons. Based on its design specifications, the Ballville Dam and the impounded area are no longer necessary as a PWS for the City.

On April 22, 2011, Ballville Hydroelectric Group, LLC filed an application with the Federal Energy Regulatory Commission (FERC), pursuant to section 4(f) of the Federal Power Act, proposing to study the feasibility of the Ballville Dam Hydroelectric Project No. 14153, to be located at the existing Ballville Dam on the Sandusky River, in the City of Fremont, in Sandusky County, Ohio. A preliminary permit was awarded to the Ballville Hydroelectric Group, LLC by FERC in August 2011. This preliminary permit was issued for a period effective from August 1, 2011 and ending either 36 months from the effective date or on the date that a development application is accepted for filing, whichever occurs first (FERC 2011).

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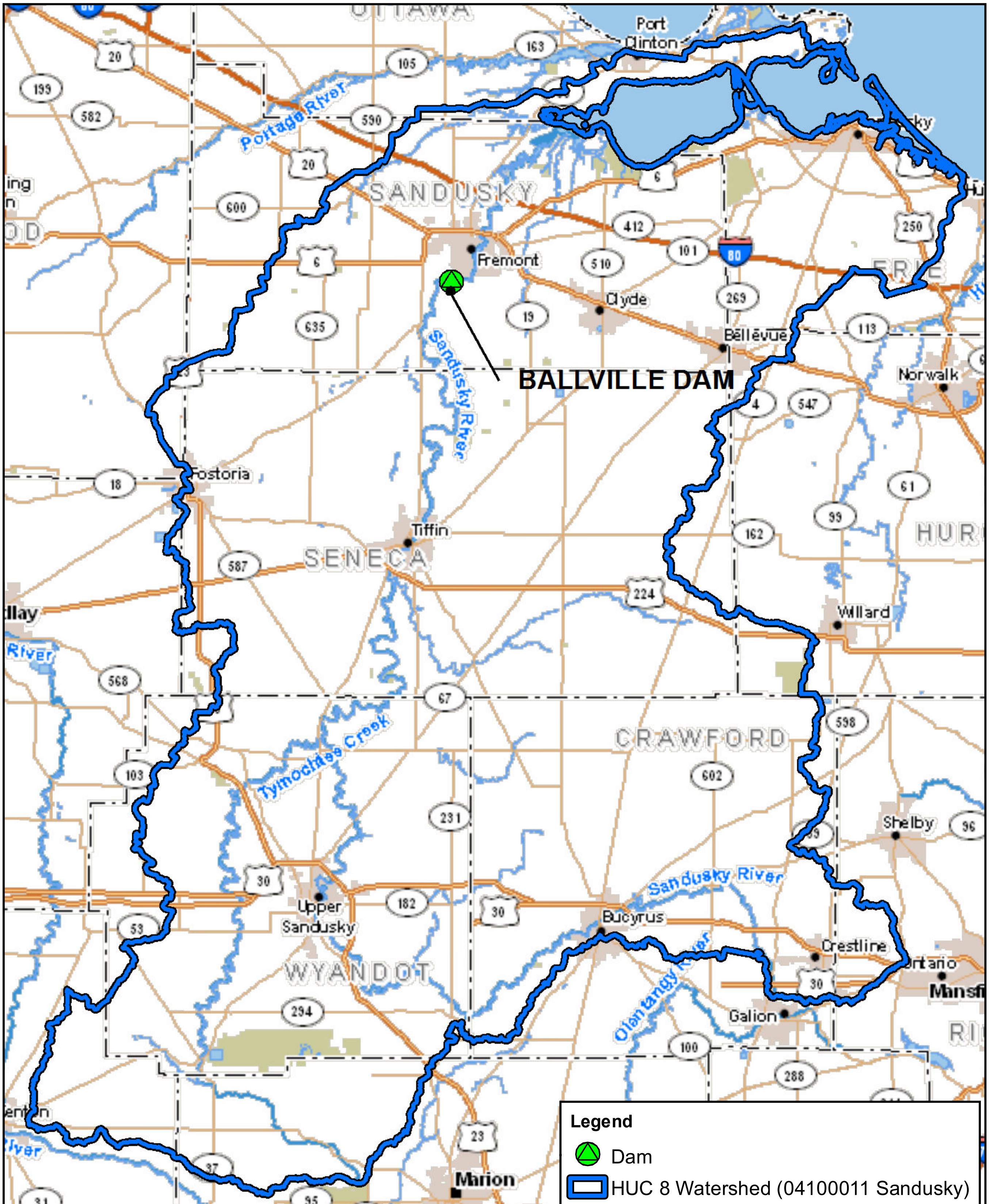
[1] OAC Rule 3745-81-11(A) states that the maximum contaminate level for nitrate for all Public Water Systems (PWSs) is 10 milligrams per liter.

Progressive deterioration of the dam and associated sea wall has been noted in successive inspections beginning in 1980, however the last known maintenance performed on the structure occurred in 1969 (ODNR 1981; ODNR 1999; ODNR 2003; ARCADIS 2005). The ODNR informed the City in 2004 that if a remediation schedule for the dam was not submitted and approved by December 1, 2007 legal enforcement actions could result. In August 2007, the ODNR issued a Notice of Violation (NOV) to the City stating that, as a result of its poor condition, the dam was being operated in violation of the law. In June 2011, the ODNR extended timeframes for bringing the dam into compliance (ODNR 2011a) in recognition that a new PWS reservoir was being completed. This letter noted that extension of the schedule for compliance did not remedy concerns regarding the condition of the dam.

1.3.2 The Sandusky River Ecosystem

The Sandusky River is one of Ohio's largest tributaries to Lake Erie, about 130.5 miles (210 kilometers) in length with a watershed encompassing 1,420.9 square miles (3,680 square kilometers) that drains into the 36,304.7 acre (14,692 hectare), estuarine-like, Sandusky Bay before entering the lake proper (Figure 1-2). In 1970 approximately 70 miles (112.7 kilometers) of the Sandusky River was designated as the state of Ohio's second scenic river. Designation starts upstream at the Route 30 Bridge in Upper Sandusky and extends to the Roger Young Memorial Park in Fremont, and includes the portion of the river within the project area. The geology of the basin is dominated by unconsolidated glacial deposits overlying limestone, dolomite, sandstone, and shale bedrock. Most of the soils are formed from glacial parent material and are fertile with high clay content. Agriculture is the predominant land use (84%) and water quality problems arise from agricultural runoff (nutrients, agricultural chemicals, and increased suspended sediment loads). River connectivity is disrupted by a low-head dam near the City of Tiffin, Ohio (39.8 river miles [64 river kilometers] from Sandusky Bay) and by the Ballville Dam near the City of Fremont (19 river miles [29 river kilometers] from Sandusky Bay).



Basemap: OGRIP

Sandusky River Watershed

N
W E
S

Ballville Dam Project

0 2.5 5 Miles

Figure 1-2

Together, the Sandusky River and Bay system provide important habitat for a variety of flora and fauna in both upland and wetland areas. Waterfowl and other migratory birds depend on this system for breeding and migration habitat. A diverse fish community of 88 native species use the river and bay system for some or all of their life stages, including Walleye (Sander vitreus), White Bass (*Morone chrysops*), Channel Catfish (*Ictalurus punctatus*), Smallmouth Bass (Micropterus dolomieu), Redhorse Suckers (*Moxostoma spp*.), Buffalo (*Ictiobus spp*.), and Northern Pike (*Esox lucius*) (Bogue 2000). The Greater Redhorse (M. valenciennesi) is a state-threatened species that continues to be observed in the river (ODNR, unpublished data). Walleye and White Bass support significant spring river fisheries in the Sandusky River, providing about ~196,000 angler hours during March-April fisheries in 2009, while ranging from approximately 102,000 to approximately 367,000 hours annually since 1975 (Table 4.2.1, ODNR 2010).

Other species support relatively small fisheries on their largely residential (non-migratory) river populations but play important ecological roles in the fish community. Dam removal would increase fish access to habitat by nearly 2-fold in terms of river length (18 miles [29 km] below dam, 21.7 miles [35 km] above dam to next dam) and about 15-fold in terms of gravel-cobble areas (approximately 19.8 acres [8 hectares] below dam, approximately 301.5 acres [122 hectares] above dam). An improved river flow regime with open access to substantially more habitat should increase the abundance of virtually all species, and likely species diversity as well, when compared to present conditions both above and below Ballville Dam.

The importance of restoring Sandusky River habitat is addressed in a formal state management plan of the ODNR, e.g., the Sandusky River Basin Fisheries Tactical Plan (Davies and Tyson 2001). The authors of the plan indicate that “dams alter the connectivity, hydrology, and water quality characteristics of stream flow. Dams with sediment trapping capacity in their reservoir (such as the Ballville) tend to increase available energy for stream scour and channel incision downstream. The management objective is to re-establish stream flow conditions in the Sandusky River to mimic natural flow regimes and conveyance in channels.” They further add that “removal of the Ballville Dam is a cornerstone in the rehabilitation of aquatic habitats in the Sandusky Hydrological unit,” which includes the Sandusky River and Sandusky Bay. Restoration of hydrological connectivity and fish passage in major Lake Erie tributaries is also identified in the ODNR Division of Wildlife’s Strategic Plan (ODNR 2011b), and the Lake Erie Tactical Plan (ODNR 2013b), which directs management authorities when possible to identify, protect, and restore lost or critical habitat in the watershed and minimize impacts to Lake Erie.

1.3.3 Impact of the Ballville Dam on Aquatic Resources

Water bodies within the State of Ohio have, by law, designated beneficial uses that are protected by water quality standards. Within the project area, the Sandusky River’s Aquatic Life Use Standard is Warm Water Habitat (WWH). The Sandusky River has also been designated for Public Water Supply, Agricultural Water Supply, Industrial Water Supply, and Primary Contact Recreation. The Sandusky River was sampled at five locations between river mile (RM)

5.5 and 18.05 in 2009. The Sandusky River at the Ballville Dam (RM 18.05) was found to be in non-attainment of the WWH designation due to siltation and direct habitat alteration.

Ballville Dam divides the aquatic ecology of the lower Sandusky River, altering biological functions and impacting both riparian and aquatic habitats otherwise provided by a historically connected Sandusky River watershed. One major ecological impact is that the Ballville Dam represents an impassable barrier to upstream movement of all aquatic organisms and to downstream movement of many aquatic organisms. Ballville Dam has an impact on habitat accessibility, habitat conditions, and the overall ecology of its impounded area and the downstream reaches for all species which utilize those areas. This includes year round resident species, as well as migratory species moving into the system during spawning life stages. Included on the list of impacted species are freshwater mussels as well as sport and non-sport fish species such as Greater Redhorse, Walleye, and White Bass. A portion of this impact was noted historically by Trautman (1975), stating that "…the Lake Erie tributaries, with their spawning and nursery areas, formerly contributed greatly to the huge populations of some species of fishes in the lake. As was also recorded from the Maumee River many fish species migrated into and spawned in the Sandusky River before the event of dams, extensive drainage, increased turbidity, and other pollutants." Trautman (1975) further comments that "…more than half of the 88 fish species recorded for the Sandusky River have decreased in numerical abundance since 1850 or have been extirpated. These include species prevented from migrating upstream to spawn because of dams; those whose spawning habitat has been largely destroyed by agricultural practices, ditching and draining; those who require considerable aquatic vegetation; and/or those intolerant to turbidity. Many species of former economic importance, such as Sturgeon, Muskellunge and Walleye, have been largely or entirely eliminated."

The Sandusky River is a tributary to Lake Erie and provides important habitat for many aquatic species. Numerous species of fish and mussels utilize the Sandusky River for a variety of life stages, including spawning, prey resources, and predator evasion. One example of this is White Bass, which utilize river habitat to reproduce. Current otolith microchemical research suggests that as much as 80 percent of young of year White Bass captured in the central basin of Lake Erie appear to have been spawned in or near the Sandusky River (Jeremiah Davis, Communication; Bowling Green State University). Another example of the species that rely on this resource is the Sandusky River Walleye stock, or sub-population.

Walleye are a highly migratory species in the region, moving throughout all three basins of Lake Erie and northward into Lake St Clair and Lake Huron (Wang et al. 2007). The Sandusky River Walleye stock is recognized by fisheries managers as one of several discrete Walleye stocks that contribute to inter-jurisdictional fisheries in the U.S. and Canada (Bigrigg 2008). Although current migratory Walleye and White Bass stocks that spawn in the Sandusky River support a smaller percentage of the fisheries in the river and in Lake Erie, it is thought that increases in their abundance would lead to commensurate economic benefits at local, state, and inter-jurisdictional scales. ODNR research indicates that the Sandusky River Walleye stock is constrained by the amount (approximately 19.8 acres [8 hectares]) of spawning habitat below the dam, and that this extant habitat is likely deteriorating from a lack of gravel replenishment (Davies 1994; Plott 2000). Their research also indicates that approximately 301.5 acres [122 hectares] of suitable spawning habitat exists upstream of the dam, and that, when relocated to that location, Walleye can spawn and produce larvae from the upstream habitat (Davies 1994; Plott 2000; Jones et al. 2003; Cheng et al. 2006, McMahon et al. 1984). However, data from surveys completed in 2009 and 2010 did not capture any Walleye (Ross 2013). While this research may not guarantee that the Sandusky River Walleye stock would immediately find and use new habitat, it does support the premise that the major impediment to Walleye reproduction in this system, lack of spawning habitat, would be addressed in part through dam removal (Plott 2000; Thompson 2009).

Similar to Walleye, the expansion of available habitat would benefit many other species of fish such as the White Bass which utilize the Sandusky River for at least a portion of their life history. Surveys completed by Ross (2013) did not capture White Bass upstream of the Ballville Dam in 2009 and 2010. Habitat expansion may assist in returning this and other native species to the upstream reaches of the river which have been absent for many years.

Additionally, the Ballville Dam has altered natural hydrologic and sediment transport functions in the Sandusky River. Notably the dam currently traps coarse sediment in the upper portion of the impoundment as water velocities are reduced and they are no longer carried by stream flows. In an unobstructed system these coarse materials would naturally be transported downstream (ODNR 2010). The supply of such coarse sediments is necessary for replenishing and maintaining downstream spawning habitat, which is important for many native aquatic species utilizing these areas during a series of life stages. Alternatively, few clays or fine sediments are currently trapped by the dam and are instead transported over the structure within the water column to habitats downstream. The restriction of coarse sediments, while conveying fine sediment downstream, can negatively impact important habitats, including spawning areas, by filling in interstitial spaces likely leading to a more homogeneous benthic environment (Plott 2000; Poff and Hart 2002). For further explanation of the status of impounded sediments see Section 4.1.2.1.2.

1.4 DECISION REQUIRED

Upon the completion of the NEPA process, including a 30-day public comment period on the Final SEIS, the Service Region 3 Regional Director at Bloomington, MN will consider whether the facts and analyses provided herein support the issuance of federal funding in support of the Preferred Alternative. A Supplemental ROD will then be issued detailing consideration of the environmental analysis for the project in accordance with NEPA.

In addition to the decision required by the Service, the USACE will also require a decision on the issuance of the necessary permits under Section 404 of the Clean Water Act (33 U.S.C. 1344 *et seq*.) and Section 10 of the Rivers and Harbors Act (33 U.S.C. 401 *et seq*.).

1.5 Purpose for Federal Action

The purposes for the issuance of federal funds and preparation of the FEIS and Final SEIS are to restore natural hydrological processes over a 40 mile (64.4 kilometer) stretch of the Sandusky River, re- open fish passage to 22 miles (35.4 kilometers) of new habitat, restore flow conditions for fish access to new habitat above the impoundment, and improve overall conditions for native fish communities in the Sandusky River system both upstream and downstream of the Ballville Dam, restoring self-sustaining fish resources. These actions would support the goals of the GLFWRA and the GLRI. The Service has ensured compliance with NEPA and other applicable Federal laws and regulations in order to satisfy project planning obligations for federal funding.

1.6 Need for Federal Action

Issuance of federal funds address the following needs related to the current conditions of the Sandusky River:

- Restore and expand upon self-sustaining fishery resources within the lower Sandusky river by providing fish passage in the Sandusky River at the Ballville Dam impoundment site in both the upstream and downstream directions.
- Restore system connectivity and natural hydrologic processes between the impounded area upstream of Ballville Dam and the lower Sandusky River, which would restore riverine fish and wildlife habitat, resulting in a net gain in the amount of free-flowing riverine habitat.

Meeting the needs listed above would likely address conditions or objectives of agreements currently in place between the City and other local, state, and federal agencies. Those may include, but are not limited to:

- Eliminating flood risks to the City of Fremont.
- Eliminating liabilities associated with the current safety conditions of the Ballville Dam including potential threats to private properties both upstream and downstream of Ballville Dam.
- Managing downstream movement of stored impoundment sediments.
- Achieving Aquatic Life Habitat Use-Attainment (as defined by OEPA in §3745-1-07 of Ohio Administrative Code) for the lower Sandusky River.
- Improving and increasing aquatic habitat availability in the lower Sandusky River downstream of the Ballville Dam site.

The Final SEIS incorporates the evaluation of impacts to the human environment that are expected to occur as a result of federal funding for this project completed in the FEIS and is intended to consider additional information available at this time.

2.0 FINAL SEIS DEVELOPMENT, IDENTIFICATION OF ALTERNATIVES, AND PUBLIC CONSULTATION

2.1 SUMMARY OF FINAL SEIS DEVELOPMENT PROCESS

Pursuant to NEPA (40 C.F.R. 1502) an SEIS will be prepared when there is significant new information relevant to environmental concerns and bearing on the proposed action or its impacts.

On July 7, 2015, the Sierra Club filed suit in District Court alleging that the City, the Service, and USACE (as the cooperating agency) failed to "lawfully consider and mitigate the environmental harm that the release of the massive quantity of contaminated sediment that has grown behind the dam for over a century will cause downstream to the Sandusky River, Sandusky Bay and Lake Erie following the dam's removal in the manner approved in the EIS and, further," failed to "lawfully consider reasonable alternatives to addressing this sediment in a more environmentally protective manner." Concurrently, the USACE determined that further testing of the sediments impounded by Ballville Dam would be required to complete the Section 404 permitting process. The Service determined that this additional sediment data would add significant new information that could inform our understanding of the impacts of the Proposed Alternative on the environment in the area (Figure 1-1). As such, the Service worked closely with USACE, ODNR, and the City to develop the plan to complete the testing, reevaluate the potential impacts based on the analytical results, and incorporate it into our decision making process through the completion of this Final SEIS.

In addition to the noted allegations, the suit detailed other concerns also related to sediment management and sediment impacts. These topics include questions regarding the estimate of total quantity of sediment impounded by Ballville Dam, the potential impacts of the Proposed Alternative on harmful algal blooms (HABs) in the Sandusky River and Lake Erie due to the proposed sediment release, the potential impacts of the Proposed Alternative on downstream habitats due to sediment release, the accuracy of cost estimates of sediment removal within the EIS, evaluation of a by-pass and excavation alternative provided in comments on the FEIS, and the potential for beneficial reuse of sediments impounded by Ballville Dam. Although we concluded that these topics were sufficiently addressed in the FEIS, we provide additional review and assessment in this Final SEIS to help further clarify the issues given that the SEIS was necessary based on USACE's requirements for additional sediment data. To complete this aspect of the Final SEIS we consulted subject matter experts to help review FEIS materials and clearly articulate our understanding of them. The resulting additional information and explanation has been incorporated within this Final SEIS.

2.2 REVIEW OF PERTINENT FEIS ALTERNATIVES

A total of eleven alternatives were developed and described in the FEIS (See Section 2.2). They were developed during scoping and throughout the EIS process based on comments and other ideas we received from members of the cooperating agencies and the public. This suite of alternatives was meant to encompass a wide array of options and ideas on how to approach the Ballville Dam Project. As noted in Section 2.2 of the FEIS, alternatives were screened out after evaluation based on concept constructability, functionality, and estimated costs. Provisions in NEPA require that alternatives meet (or meet most of) the purpose and need, and be technically and economically feasible. The alternatives that were carried forward for more detailed analysis in the FEIS were those that best met the purpose and need, minimized adverse effects to the human environment, were economically and technically feasible, and represent a range of reasonable alternatives. Some alternatives did not fully meet the purpose and need, but they had potential to minimize some types of effects to the human environment or help create a reasonable range of alternatives for consideration by decision-makers.

As described in Section 2.3 of the FEIS, there were seven conceptual alternatives considered but eliminated from further evaluation through the EIS process (FEIS Section 2.3.1-2.3.7). Upon review of these seven alternatives and the new information regarding sediment analysis, six of them remain unaltered and removed from further consideration primarily due to infeasibility and/or meeting only portions of the purpose and need while not substantively reducing environmental effects to the human environment. These six conceptual alternatives are Dam Removal without Installation of an Ice Management System (FEIS Section 2.3.1), Dam Removal with an Active River Ice Management Plan (FEIS Section 2.3.2), Hydroelectric Generation (FEIS Section 2.3.3), Flood Control Structure (FEIS Section 2.3.4), Reconfiguration of Dam and Removal of Sluice Gates (FEIS Section 2.3.5), and Fish Stocking, Capture and Release (FEIS Section 2.3.6). We incorporate these alternatives as described in the subparts of Section 2.3 of the FEIS.

The remaining conceptual alternative, Dam Removal with Impoundment Dredging (FEIS Section 2.3.7) describes an alternative approach to sediment management. The data from the additional sediment analysis completed in 2015 is directly relevant to this alternative. Section 2.2.1 below describes the re-evaluation of this alternative with additional information and description.

In addition to the alternatives evaluated in the FEIS, we received one comment during the FEIS comment period that suggested a dam removal technique being used in other locations within the United States as a potential alternative to be considered for this site. We considered this technique in relation to the site-specific information for the Ballville Dam Project and developed an alternative for consideration. This new alternative is described in section 2.2.2 below.

In May 2016, a meeting was held with Sierra Club representatives, Ohio DNR, and the Service to discuss comments on the Final SEIS. At this meeting the Sierra Club suggested a conceptual alternative for the management of sediment currently impounded by Ballville Dam. Following that meeting, the Sierra Club and the owner of Universal Farms LLC (a local business specializing in yard waste recycling and mulch manufacturing) met with the City where this concept was also presented as an option to reduce sediment movement downstream. After working with the City, based on our individual meetings with Sierra Club representatives, this alternative was further developed and considered and is described in section 2.2.3.

2.2.1 Dam Removal with Impoundment Dredging

The disposition of sediment trapped by Ballville Dam since its construction in 1913 is integral to understanding possible environmental impacts and the feasibility of dam removal alternatives. As such, it was proposed through the cooperating agency group and through public scoping that we formulate an alternative that includes sediment dredging within the impoundment prior to dam removal as a way to decrease any potential environmental impacts of sediment movement downstream. To investigate this alternative we reviewed the existing estimates of sediment currently stored behind Ballville Dam, estimated sediment dredge costs, data regarding the quality (i.e., nutrient status, contamination) of the impounded sediment, models of sediment release scenarios, and average sediment loading data in the Sandusky River.

Potential impacts of sediment release to downstream habitat are related, in part, to the amount of sediments within the impoundment, specifically those sediments that are potentially mobile (See Section 4.1.2.1.2). Sediments in heavily vegetated areas and those in areas away from the main channel on the inside bend are less likely to mobilize and move. Thus, only a portion of the total impounded sediment would be expected to mobilize and move downstream in a dam removal scenario.

The next step is to consider the method in which dredging the impoundment would be accomplished and then to estimate the cost. Dredging would occur by use of a hydraulic dredge staged on a floating barge. The sediment slurry would be pumped from the impoundment to a dewatering site. In general, hydraulic dredges have a distance limit for pumping slurry of approximately 1,000 feet. However, due to access issues, limited staging area size, and length of reservoir this analysis considers the use of a specialty dredge or the use of booster pumps that can pump up to 2,000 feet. The principal constraint encountered with dredging is the requirement to dewater the dredged slurry prior to disposal. In this case, substantial acreage to stage the dewatering process is needed. The impoundment is bordered on both banks by private property, and/or jurisdictional wetlands making this a challenge to overcome, for this alternative an area of backwater slew and side channel in the southern portion of the impoundment near the created island was considered as a viable disposal location. Geotextile “Geotubes” are commonly used as a dewatering technique when a limited amount of space is available and was considered needed in this case as well. Once the slurry is dewatered in the Geotubes, it would be hauled to a landfill for disposal (see below for disposal). This would require numerous large dump trucks to load and haul away the sediment.

Prior to the development of this alternative, Evans et al., 2002 indicated that a partial dredge option (removing 27% of the sediment, approximately 460,000 cubic yards) would cost approximately $6.3 million excluding costs associated with on land disposal at that time. Alternatively, Stantec Inc. provided a cost estimate for a partial dredge option at $26.1 million as well as a full dredge option at $93.4 million, the methodology for which can be found in FEIS Appendix A2. It is important to note that these estimates come with a high range of variability. This variability is due to complications that come with dredging in a small impoundment with both time (i.e., seasonal accessibility issues) and site-specific (i.e., overall accessibility) challenges as compared with dredge operations in larger rivers systems and open lake scenarios. Variability in the quantity of sediment to be removed further affects total cost.

At a minimum, without costs associated with on land disposal included, the partial dredge estimate by Evans et al., 2002 of $6.3 million is approximately equivalent to the total cost estimate of the Proposed Action, $6.28 million (See Section 3.1.1.4). Therefore, even under the most conservative of our estimates available, if partial impoundment dredging were included as a sediment management technique within the Proposed Action, the total cost estimate increases from $6.28 million to $12.58 million.

The results of the sediment analyses (See Section 5.1.2) as well as the anticipated short term nature of the impacts downstream during a sediment release scenario (See Section 5.2.2) indicate there is little long term risk to the Sandusky River and downstream habitats from the quantity or the quality of the impounded sediments if released. Thus, sediment studies do not indicate a need for management of sediment to this extent. While this alternative could meet portions of the purpose and need, likely reducing some short term environmental impacts downstream, our current understanding of the affected environment indicates that this level of sediment management is not going to provide a greater level of risk abatement for the Sandusky river ecosystem long term. Additionally, due to the estimated costs, when viewed in light of the expected limited long term risk of impacts downstream, it was determined that dredging the sediment was neither necessary nor economically feasible. Therefore, this alternative was not carried forward for further analysis.

2.2.2 Dam Removal with By-Pass Channel and Impoundment Excavation

As noted in Section 4.2.2.1.2, approximately 840,000 cubic yards of sediment exist behind Ballville Dam. The disposition of the trapped sediment is key to understanding possible environmental impacts and the feasibility of dam removal alternatives. As such, it has been proposed that one way to address these sediments is by employing a by-pass channel allowing the impounded sediment to dry out and be excavated. This technique would be employed as a way to manage and reduce the downstream movement of trapped sediment and limit any potential negative impacts of that movement on habitats in the Sandusky River.

To develop and analyze this alternative in relation to our purpose and need, we consulted experts who had worked on projects where this technique has been employed. Based on those examples, this technique has been an effective way to reduce impacts of sediment transport downstream, specifically in cases where it has been identified that those sediments would have created significant long term detrimental effects on downstream fish habitat or infrastructure. For example, the Milltown Dam project in Montana employed this technique to remove 2.3 million cubic yards (1/3 of the total aggradation in that case) of sediments to ensure the high levels of copper and arsenic did not travel downstream and negatively impact trout habitat, human health, or create complications with dams and other infrastructure (USEPA 2004).

Similar to the proposed action, this technique at the Ballville Dam site would require a notch in the dam to begin forming a channel and dewatering the impoundment. However, in this alternative a channel would be engineered and built, diverting all river flow to one side of the impoundment. This engineered channel would have to be able to safely contain any expected high flow events during the duration of the work, allowing the remaining areas of the impoundment to dry while preventing the sediment from moving downstream. After a period of time, the then dry sediment on the opposite side of the impoundment could be excavated and moved via truck to an offsite location. Once excavated to the appropriate level, the river could be diverted to the opposing side of the impoundment, the dam removed further, and then the excavation process repeated. Some conceptual challenges associated with this alternative specific to the Ballville Dam project are design and engineering complexities related to controlling and diverting the river channel and excavation activities in close proximity to homes and private property, as an increase in noise and air pollution (dirt and exhaust from heavy equipment) during excavation actions would be expected. Additionally, biological or hydrological processes would likely be impacted during the diversion, channelization, and excavation process.

Additional costs would be incurred for engineering and constructing the temporary bypass channel, and excavating and disposing of the sediment. Though these costs have not been estimated specific to this alternative, excavation would be the primary technique for sediment removal. As such it is reasonable to assume they would be similar in cost to the “Dam Removal with Sediment Excavation and Beneficial Reuse of Sediments” alternative described in Section 2.2.3 (See also Appendix A1 and Appendix A2).

The results of the sediment analyses (See Section 5.1.2) as well as the anticipated short term nature of the impacts downstream during a sediment release scenario (See Section 5.2.2) indicate there is little long term risk to the Sandusky River and downstream habitats from the quantity or the quality of the impounded sediments if released. Thus, sediment studies do not indicate a need for management of sediment to this extent. While this alternative could meet portions of the purpose and need, likely reducing some short term environmental impacts downstream, our current understanding of the affected environment indicates that this level of sediment management and system disturbance within the impoundment is not going to provide a greater level of risk abatement for the Sandusky river ecosystem long term. Additionally, due to the estimated costs, when viewed in light of the expected limited long term risk of impacts downstream, it was determined that by-pass and excavation was neither necessary nor economically feasible. Therefore, this alternative was not carried forward for further analysis.

2.2.3 Dam Removal with Sediment Excavation and Beneficial Reuse of Sediments

As noted in Section 4.2.2.1.2, approximately 840,000 cubic yards of sediment exist behind Ballville Dam. The disposition of the trapped sediment is key to understanding possible environmental impacts and the feasibility of dam removal alternatives. As such, it has been proposed that one way to manage and reduce the downstream movement of trapped sediment and limit any potential negative impacts of that movement on habitats in the Sandusky River and concurrently reduce associated project costs is by draining and excavating the impoundment and then beneficially reusing sediments. This idea is meant to not only reduce sediment movement downstream, but also offset overall project costs. To develop this alternative, the City used input directly from a meeting with Sierra Club representatives and a local business owner specializing in yard waste recycling. During that meeting it was estimated that the excavated sediment, once processed, could be sold for approximately $20 per cubic yard.

Following their meeting with Sierra Club and the local business owner, the City then worked with their contractors to identify potential options and any associated logistical concerns. Specifically, considerations for wetland development post dam removal was a factor in approaching this idea, as were factors such as logistical feasibility, site access, and overall cost of the excavation. The details in this alternative are further described in a letter from the City to the Service (Appendix A1 and Appendix A2).

The alternative would require first notching the dam to lower the water level and expose sediment which could then be seeded to stabilize it, allowing greater access to the site for future excavation activities. The following fall the remainder of the dam would be removed and the impoundment drawn down to expose the remaining sediment. Once exposed, the remaining sediment would be allowed to de-water for a period of time to help it consolidate and thereby ease logistical challenges associated with excavation and grading, however specialized equipment is still expected to be needed over the likely unstable material. City engineers and contractors estimate this approach would allow for the removal and reuse of approximately 200,000 to 300,000 cubic yards of sediment. As sediment is removed from the impoundment, it would be moved via trucks to a local location for processing into useable topsoil to be sold on the market. It is important to note that through this alternative, some sediment would need to remain in place as a component of the wetland mitigation work for the project.

City contractors gathered information on the estimated costs associated with this alternative. They estimate a cost of $50 per cubic yard of sediment excavated, due in part to the specialized equipment needed to excavate soft sediment with limited access points (Appendix A1 and Appendix A2). They also added $5 per cubic yard for the trucking and transportation costs. They note that the estimated $55 per cubic yard does not include any costs associated with engineering, permitting, material processing, or dewatering.

Based on the evaluation of estimated costs, this alternative would cost approximately $11M to $16.5M, depending on the quantity of sediment excavated, in addition to the estimated cost of dam removal itself. However, a major component of this alternative is processing the sediment for reuse and eventual resale to recover expenses of the cost of the overall project. Unfortunately, at the estimated cost of $55 per cubic yard for removal and trucking plus other associated costs, at an estimated $20 per cubic yard sale price, there would be an approximate loss of $25 per cubic yard. Instead of recouping overall project costs, these estimates would translate into a net cost of this alternative of approximately $7M to $10.5M, in addition to the cost of dam removal.

The results of the sediment analyses (See Section 5.1.2) as well as the anticipated short term nature of the impacts downstream during a sediment release scenario (See Section 5.2.2) indicate there is little long term risk to the Sandusky River and downstream habitats from the quantity or the quality of the impounded sediments if released. Thus, sediment studies do not indicate a need for the excavation of impounded sediments. While this alternative could meet portions of the purpose and need, likely reducing some short term environmental impacts downstream, our current understanding of the affected environment indicates that the excavation of impounded sediments is not going to provide a greater level of risk abatement for the Sandusky river ecosystem long term. Additionally, due to the estimated costs, when viewed in light of the expected limited long term risk of impacts downstream, it was determined that excavation along with beneficial reuse of the impounded sediment was neither necessary nor economically feasible. Therefore, this alternative was not carried forward for further analysis.

2.3 PUBLIC AND AGENCY INVOLVEMENT IN THE DEVELOPMENT OF THE FINAL SEIS

The Final SEIS is focused on specific elements and questions regarding sediment disposition in relation to the Proposed Alternative from the FEIS. As such, we worked closely with USACE, City, and ODNR to clarify our understanding of different key elements and develop a scope of work for sediment testing. Following that effort, we also consulted with internal Service experts and external scientific experts to assess our current understanding in relation to the expected environmental consequences of the Ballville Dam Project.

The Service published a Notice of Availability of the Draft SEIS in the Federal Register, and accepted comments received or postmarked within 45 days of publication. Comments received were reviewed and incorporated as appropriate in the Final SEIS.

The Service will publish a Notice of Availability of the Final SEIS in the Federal Register, and will accept comments received or postmarked within 30 days of publication. The Service's decision on issuance of Federal funding will occur no sooner than 30 days after the publication of the notice of the Final SEIS in the Federal Register and will be documented in a Supplemental ROD.

The Service does not have a formal administrative appeal procedure for NEPA decisions. Judicial review of a Service NEPA decision can be accomplished in Federal court under the Administrative Procedure Act (5 U.S.C. §500 *et seq*).

3.0 PROPOSED ACTION AND ALTERNATIVES

3.1 REVIEW OF ALTERNATIVES FULLY ANALYZED IN THE EIS

The FEIS carried forward four alternatives for further evaluation, including a No Action Alternative. These four alternatives as described in Section 3.1 of the FEIS were:

- Proposed Action - Incremental Dam Removal with Ice Control Structure – Currently awarded GLFWRA funding would be provided to ODNR, working with the City, to remove the dam and reseed the area over a period of months and years in a series of phases. This includes the construction of ice control structures (ICS) to mitigate for ice jamming and flooding.

- Alternative 1 - No Action – Currently awarded GLFWRA funding would not be provided to ODNR or the City for the Project. Under this alternative the dam would remain in place. The City would rehabilitate the dam to meet safety standards

- Alternative 2 - Fish Passage Structure – Currently awarded GLFWRA funding would not be provided to the ODNR or the City due to the language and objectives of the original GLFWRA proposal. Under this alternative the City would rehabilitate the dam to meet safety standards, and add a fish elevator structure.

- Alternative 3 - Dam Removal with Ice Control Structure– Currently awarded GLFWRA funding would be provided to the ODNR, working with the City, to remove the entire dam during one construction action preceded by the construction of ICS to address ice jamming and flooding.

These four alternatives were designed during EIS scoping to meet the purpose and need of the project, while addressing concerns identified during scoping, including sediment management and impacts due to potential releases of impounded sediment. The new information as described in Section 4.1.2.1.3 as a result of the sediment testing and analysis completed in September 2015 does not alter the design of these alternatives. These fully analyzed alternatives still address the purpose and need for the project as well as the concerns identified through scoping over the course of the EIS process to date.

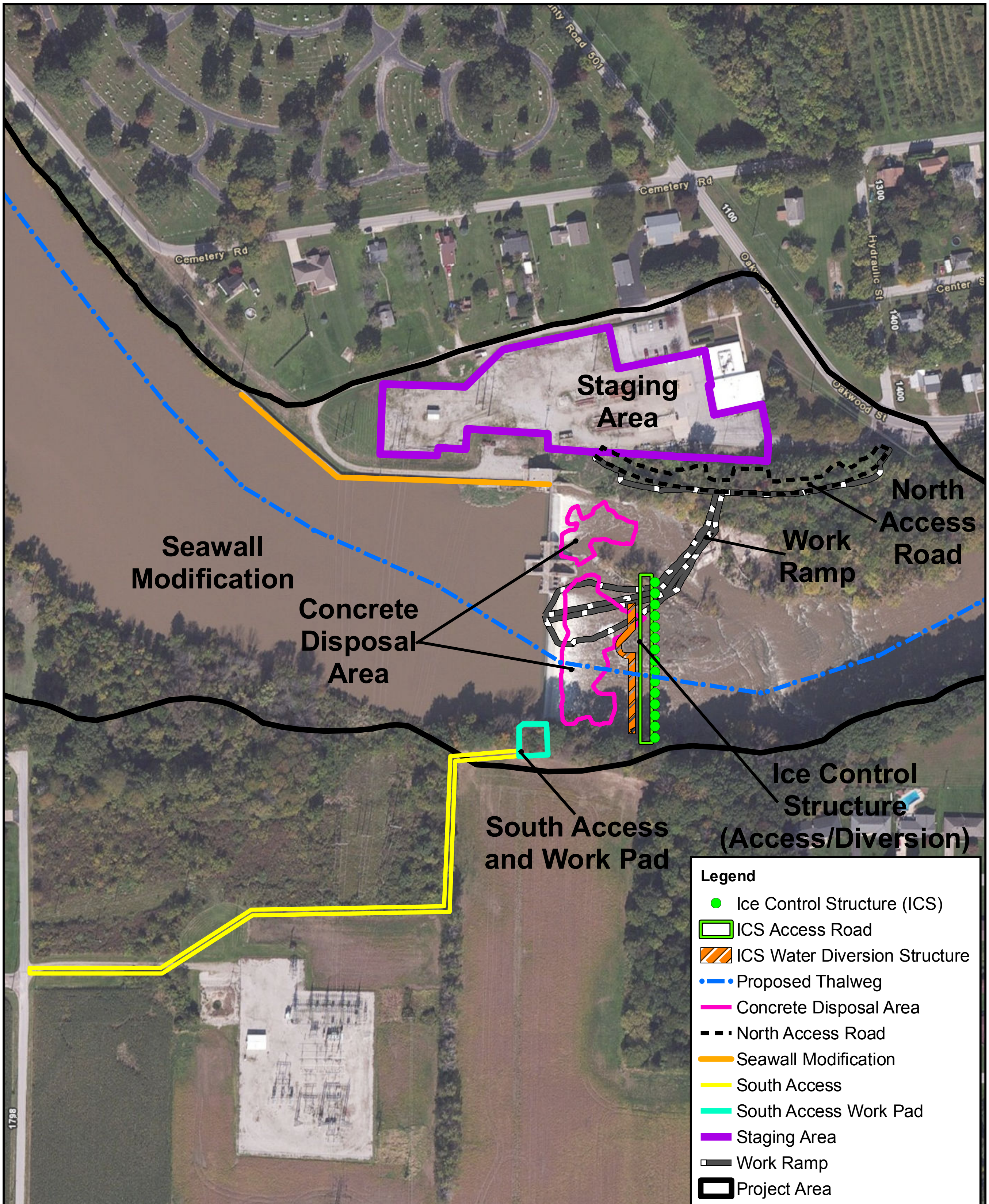
It should be noted that since the publication of the ROD, the City, Stantec, and USACE Cold Regions Research and Engineering Laboratory (CRREL) have engaged in discussions regarding the design of the ICS identified as a component of the Proposed Action and Alternative 3. Discussions have focused on three elements of the design, floodplain relief, pier spacing, and pier strength. In light of these conversations, the Service sought additional clarification of the Proposed Action and Alternative 3 to ensure these alternatives remain unchanged for the purposes of the analysis in this Final SEIS. The Service has been informed by the City that they are confident in the design of the ICS and that it has been completed in compliance with applicable guidance and standards.

Additionally, between the publication of the Draft SEIS and the publication of the Final SEIS, the City has constructed the ICS. This was completed from September through October 2016 using their own funding under a separate 404 permit approved by the Corps. The Service has continued to work closely with the City of Fremont on this component of the project to understand its relationship to the Ballville Dam Project as a whole however the Service was not involved with ICS permitting or installation. ICS planning has been included in the EIS and SEIS documents for completeness and is again included here in the Final SEIS alternatives to depict the complete suite of actions. In the Proposed Action (See Section 3.1.1) and in Alternative 3 (See Section 3.1.4), ICS construction appears in Phase 2C and 1B respectively, however completing it first does not substantively change either alternative or how these alternatives are evaluated. Therefore, these alternatives have been updated to note the completion of ICS construction in their timelines, but otherwise remain the same as they appeared in the FEIS and Draft SEIS for consistency.

This approach is meant to clearly state the fully evaluated alternatives in relation to the new sediment testing results and how those results where incorporated into the analysis for each alternative (see Chapter 5).

3.1.1 Proposed Action – Incremental Dam Removal with Ice Control Structure

The Proposed Action would be divided into three phases with each phase having multiple objectives for meeting dam removal goals. In summary, the phases are 1.) initial notching of dam; 2.) sediment stabilization, dam removal, and ICS construction; and 3.) seawall modification and restoration of the project area. Phase 3 would also include the demolition of any remnants of Tucker Dam, if necessary. A detailed description of the Proposed Action can also be found in FEIS Appendix A4. Figure 3-1 provides location information for the Proposed Action. The three phases of demolition, construction, and restoration are discussed further in the following sections.



Basemap: ESRI

Proposed Action; Primary Area of Demolition and Construction

N
W E
S

Ballville Dam Project

0 400 800 Feet

Figure 3-1

3.1.1.1 Phase I – Initial notching of Dam

3.1.1.1.1 Phase 1A – Construct access to south abutment (Approximately September 2016)

The first action would be to develop a temporary access road to the south dam abutment. Access would be from Yingling Road at its intersection with Laird Drive. From this intersection an existing gravel drive to an Ohio Power Company substation would be used for access and as an equipment staging location after receiving a temporary construction easement from the Ohio Power Company. No trespassing signage and appropriate gating, if necessary, would be posted to control access to the project area. Access to the dam would track northeastward from the existing gravel drive to the eastern edge of a field adjacent to the substation. At the east property line of this field, access would continue northward along the line until reaching the southern dam abutment. Trackhoes and work trucks would be the primary equipment used on the temporary access road.

The access road would be the width of a trackhoe and approximately 850 feet (259.1 meters) in length. No improvements such as spread gravel or grading would be anticipated. As necessary, a limited number of trees may require removal at the property line crossing and at the dam abutment work pad location.

The work pad at the south abutment would be approximately 0.5 acre (0.2 hectares) in size. Approximately half of the work pad is wooded and would require tree removal. Limited onsite grading would be required to ensure a level work pad to safely use the trackhoe for Phase 1B. Soil erosion measures such as silt fencing would be put into place to prevent any erosion and sediment entry into the Sandusky River due to clearing and grading at the work pad. Similarly, soil and erosion prevention measures would be installed along the access road, if needed, to prevent unnecessary erosion from occurring.

The access road would be restored to previous condition during Phase 3 of the project. Compacted soil would be loosened and seeded with an approved seed mix. In the planting plan memo, planting zone 5 covers the south abutment access road. This area would be seeded with native upland grasses and forbs. Grading would not be necessary. Planting zone 4 represents the south abutment staging area. This area would have containerized trees planted. Grading would not be necessary (FEIS Appendix A6).

3.1.1.1.2 Phase 1B – Notch spillway and impoundment drawdown (Approximately November 2016)

Upon completion of the south abutment work pad, a trackhoe with a mounted impact hammer (or hoe-ram) would be used to notch the dam in order to lower the pool incrementally. The notch would be approximately 20 feet (6.1 meters) wide and result in an immediate drawdown of the impoundment by lowering part of the south spillway elevation from roughly 625 feet to 615 feet (190.5 to 187.5 meters). Approximately 96 cubic yards (CY) of concrete from the dam would be removed and directed to fall into a large scour hole below the dam. Completion of the notch would conclude Phase 1.

3.1.1.2 Phase 2 – sediment stabilization, dam removal, and ICS construction

3.1.1.2.1 Phase 2A – Sediment stabilization (Approximately March 2017, dependent on weather and stream flow)

As a result of Phase 1, approximately 20 acres (8.1 hectares) of sediment currently inundated by the impoundment would be exposed. Stabilization measures would be implemented to reduce potential mobility of the fine-grained sediment stored by the impoundment on these 20 acres. An approved mixture of seed, including containerized trees in some areas, would be broadcast across the exposed surface then mulched to prevent sediment erosion and seed desiccation (i.e. drying out) (FEIS Appendix A6). It is anticipated that a motorized spreader would be used; however, other options such as aerial seeding could be utilized if the sediment remains wetted. Approximately 1,500 square bales of hay would be necessary to adequately mulch the seeded area. Access to the area would occur via the south access road. A boat may be used to transport bales of hay and bags of seed so that they may be strategically placed in the area. The length and time of the seeding schedule would be dependent upon the access conditions due to weather and water levels.

3.1.1.2.2 Phase 2B – Construct access ramp below dam (Approximately May-June 2017)

Access for equipment to remove the dam would be from County Road 501 and from the American Electric Power (AEP) storage yard adjacent to the dam. Access to the construction site would be controlled by a lockable double swing gate placed on a temporary fence. Approximately 0.3 acres (0.1 hectares) of wooded riparian habitat would be cleared for development of the access road. The access road would be constructed of clean fill and crushed limestone. Some limited cut and fill would be necessary to meet grade specifications needed for construction traffic. The access road would be constructed to allow for dump trucks, bulldozers, and other construction equipment to access the worksite. No refueling of equipment would occur within the Sandusky River. Refueling would only occur within the project staging area (in the AEP storage yard) in order to prevent fuel spills within the waterway.

Once access to the river is established, a temporary work ramp would be constructed to allow access for equipment to reach the top of the south spillway (elevation 625 feet [190.5 meters]). The ramp would be approximately 250 feet (76.2 meters) in length and rise in elevation from 602 feet (183.5 meters) to 620 feet (189 meters) at the dam. The width of the ramp would vary by elevation from approximately 75 feet (22.9 meters) at the base to 10 feet (3 meters) along the top. Total volume of the ramp is estimated to be 7,400 CY of natural rock, crushed rock and concrete rubble. Maintenance of the ramp and access road within the banks of the Sandusky River may be more frequent than at the entry gates due to rise of water elevation during rain events. However, the impact of these rain events and subsequent ramp maintenance are expected to be infrequent due to the location of the ramp (not directly below the notch) and elevation of the modified impoundment pool (less volume being stored). Sediment and erosion control measures would be applied, as appropriate, along the length of the access road and ramp.

Water would not be anticipated to discharge over the north spillway section of Ballville Dam during the Phase 2 Construction period when the river flows are typically low and the river is being diverted through the notch. The profile of the proposed access road leading to the work ramp does include a low point in the vicinity of the river bed near the north river bank and downstream of the north spillway. This low point in the access road would act as a ford or low water crossing. Should the project site experience a rainfall event that raises the impoundment level and allows water to discharge over the top of the north spillway, the water would then discharge over the low water crossing and continue downstream. The contractor also has the option to install small culverts on the order of 24 to 48-inches in diameter in the current low point of the access ramp to allow any water that may seep through the spillway or north abutment of the dam to drain downstream without impacting the usability of the causeway as dependent on conditions.

As demolition of the south spillway and non-overflow portion of the dam occur, the temporary work ramp would be lowered and/or placed in locations to help control grade of the new bench[2] stepping up to the floodplain. The access road from County Road 501 to the work ramp would be removed during Phase 3; however the portion from County Road 501 through the wooded riparian area would remain in place for future access for removal of the debris from the ICS as well as future recreational access.

3.1.1.2.3 Phase 2C – Construct ICS (Completed[3] September – October 2016)

Access for construction of the ICS would be via the access road of Phase 2B, described above. Construction of the ICS would be located 175 feet (53.3 meters) downstream of, and parallel to, the dam. The ICS consists of 15 piers spaced 21 feet (6.4 meters) apart on centers. Overall, the piers would be 25 feet (7.6 meters) tall and six feet (1.8 meters) in diameter. Piers would be embedded approximately 15 feet into the bedrock and extend 10 feet above grade. Exposure

[2] Benches refer to areas that are bank-attached, planar and narrow, fine-grained sediment deposits occurring between the river bed and the floodplain.

[3] Between the publication of the Draft SEIS and the publication of the Final SEIS, the City has constructed the ICS. This was completed from September through October of 2016 using their own funding under a separate 404 permit approved by the Corps. The Service has continued to work closely with the City of Fremont on this component of the project to understand its relationship to the Ballville Dam Project as a whole however the Service was not involved with ICS permitting or installation. ICS planning has been included in the EIS and SEIS documents for completeness and is again included here in the Final SEIS alternatives to depict the complete suite of actions. In the Proposed Action (Section 3.1.1) and in Alternative 3 (Section 3.1.4), ICS construction appears in Phase 2C and 1B respectively, however completing it first does not substantively change either alternative or how these alternatives are evaluated.

above grade would vary based on river bed; however, piers would be uniform in top elevation at 610 feet (185.9 meters) (FEIS Appendix A5).
The installation of the ICS can be performed during modestly active flow conditions anticipated during the low flow annual periods. The Contractor would use best management practices to isolate drill cuttings and prevent concrete from entering the watercourse during installation of the piers. The Contractor would implement water management practices during the installation of the ICS piers to maintain flow in the Sandusky River.

The contractor will access the pier locations using equipment placed directly in the riverbed. During drilling and construction of the piers, river flow will be temporarily diverted around the immediate work area, thereby preventing drill cuttings and concrete from entering the watercourse. It is assumed the contractor will use a large track-mounted drill rig to core bedrock. Drill cuttings may be used onsite for the access ramp to the dam. Concrete for the ICS piers will be delivered from local suppliers using commercial rubber-tired transit mixers.

The riverbed in this area is exposed bedrock with a few areas covered or filled with fine and course sediment. The contractor may require further temporary leveling for equipment access and safe construction. Leveling material, such as sand and gravel, may account for approximately 50 cubic yards of temporary fill within the Sandusky River.

The contractor, in conjunction with the planned access ramp for the dam, would likely build a temporary access road parallel to the entire length of the ICS alignment (Figure 3-1). This road would facilitate access for smaller rubber-tired vehicles and be safer for workers on foot. The road would contain approximately 700 cubic yards of fill, mainly placed within the Sandusky River (540 cubic yards, 0.103 acres). Approximately 80 cubic yards would be placed within Jurisdictional Wetland 18 (0.019 acres) and 80 cubic yards in Wetland 6 (0.015 acres). The access road would be comprised of materials, such as large gravels and cobbles, capable of withstanding river flow. The road may have a low section to pass water flow over the access road surface. Alternatively, a number of conduits may be installed beneath the road to pass expected flows. River diversion may be local to each pier or installed to surround groups of piers as construction proceeds. River flow may be diverted partially, depending upon the location of the work. Flows through main channels would be split around pier worksites within the center of the channel. The particular system used to accomplish this would be the responsibility of the Contractor.

For ICS construction, the contractor would generally follow the below sequence:

1. Create a level access path for the construction equipment (or the equipment would travel on the exposed rock river bed) along the ICS alignment.
2. Install a river diversion system (coffer, water dams, etc.) in order to work “in the dry.”
3. Install drip pans/trays beneath equipment to catch oil and gas leaks.
4. Install a local diversion (sandbags, etc.) at each pier site to guard against cuttings and concrete from entering the water course. Deploy seepage sumps and pumps.

5. Upon completion of construction remove from the river bed any equipment, materials and placed fill.

Each pier would be constructed in three parts: drilling, reinforcement placement, and concrete placement by tremie method (pumping from the bottom up). Each shaft would be drilled approximately 15 feet into the bedrock. A truck mounted drill rig with a 6-foot (1.8 meters) diameter toothed core drum would remove 1 to 3 foot-long (0.3 to 0.9 meter) plugs of bedrock. Each plug would be extracted and drilling continued until the required depth is attained. After drilling, reinforcement is added. Reinforcement would consist of a six foot diameter circular form and a mesh of rebar assembled for structural strengthening. A cylindrical form for the concrete would extend at least 12 feet above grade to elevation 610 feet (185.9 meters). Tremie concrete would be used to fill the form, displacing any collected water. The fill volume for each pier would be approximately 26 CY and would be comprised of steel reinforced concrete. The entire ICS (15 piers) would result in nearly 390 CY of poured concrete. Equipment would be staged in the north staging area and refueled daily at this location. It is estimated that shaft construction, including drilling, reinforcement and concrete placement, could occur at a rate of one pier per day. Concrete placement is likely to occur in groups of five to 10 piers for concrete delivery efficiency. A concrete pump truck and an estimated 40 concrete mixing trucks (roughly three mixer loads per pier) would access the project area via the north access road. After the concrete has hardened the circular forms would be removed exposing the structure.

During the 50 to 75 year service life of the ICS, various maintenance activities would be required to extend each pier's service years. Concrete may experience spalling and abrasion throughout its service life. These areas would be patched with Portland cement grout or epoxy. Routine inspection of the structures would be necessary to ensure that the reinforcement is not exposed and that the concrete is maintained.

Periodic removal of debris that may accumulate on the structure may be necessary. The modified access along the north bank would be kept clear of vegetation for periodical access to the ICS for clearing debris (i.e. limbs and trees) and maintenance.

3.1.1.2.4 Phase 2D – Remove dam (Approximately September-November 2017)

After completion of Phase 2B an access road would be in place to begin demolition of the remaining dam. However, it is not until near completion of Phase 2C that demolition would begin. Demolition of the dam was originally planned to stop at the north abutment where the current carbon feed building is located as described in FEIS Appendix A4. However, the City and their contractor may determine it prudent to remove the structure during this phase in the interest of public safety and structural integrity. Demolition is expected to take approximately three months to complete including removal of the Phase 2B access ramp.

Demolition of the dam would be accomplished by a trackhoe (or hoe ram) accessing the top of the dam and enlarging the original notch from the access ramp (north). The bottom elevation of the notch would be lowered from elevation 615 feet to 610 feet (187.5 to 185.9 meters). This would allow for additional impoundment drawdown to occur while the trackhoe/hoe-ram demolishes the top of the remaining south spillway. As the south spillway is demolished, additional equipment would work to demolish the non-overflow section of the dam and move northward to demolish the north overflow area. Debris from the demolition would be directed to fall into a two large scour holes downstream of the south spillway and north overflow. The access ramp constructed in Phase 2B would be removed as the dam is reduced in elevation. The Ballville Dam structure is constructed of approximately 15,000 CY of reinforced concrete consisting of clean concrete materials (approximately 14,000 CY) made from sand and gravel river materials and approximately 800 to 1,000 CY (loose) of steel rebar. During demolition, the contractor would be instructed to only permanently fill with unreinforced concrete into the designated disposal areas (i.e. scour holes). This would require the contractor to separate the steel rebar for offsite disposal. The separation process involves breaking up the larger concrete materials into boulder to cobble size rubble using a jack hammer or hoe-ram and separating the different materials using a claw, front loader, or bull dozer. A bulldozer may be used to push and spread the clean fill materials. An estimated 1,000 CY (loose) of steel rebar and unseparated concrete (i.e. tangled within the rebar) would be hauled offsite for disposal. The cost of hauling would be approximately $10,000.00 (estimated $10.00 per CY). The entire volume of debris from demolition of the dam is estimated to be 15,000 CY. Some of the metal materials in the dam such as the old penstock, sluice gates, and raw water intake apparatus would be removed from the demolition area upon extraction. Approximately 1,900 CY of clean concrete rubble fill from the demolition would remain in the two concrete disposal areas (scour holes) in order to level the river bed. The remainder of the clean material would be utilized during Phase 2E – Channel Restoration (See Section 3.1.1.2.5).

If the carbon feed building is demolished, it would be demolished using a claw, front loader, or bull dozer. All of the demolition materials would be hauled offsite for disposal.

3.1.1.2.5 Phase 2E – Channel restoration (Approximately November-December 2017)

After demolition of the dam, channel restoration would occur. Restoration of the project area would include approximately 28,000 CY of fill consisting of offsite rock and soil materials as well as some concrete rubble from the demolished dam and leftover access ramp. This material would be used for grading of the new bank benches (See Section 3.1.1.2.2).

The proposed channel grading will consist of 1) placement of fill downstream of the current dam location, and 2) fill cut upstream of the current dam location. This channel shaping will result in construction of a terrace (See Section A-A' on sheet 8 of 19 in FEIS Appendix A5). Without this terrace the river could potentially flank the ICS rendering it ineffective.

The notching of the dam in Phase 1B is designed to "train" the river to flow through the restoration area to the south (Sheet 10 of 20 of Proposed Action Memo FEIS Appendix A4). While it is expected that the river would naturally grade it, there may be need to grade a channel lead starting approximately 300 feet (91.4 meters) upstream of the dam. Once the stream reaches bedrock the stream would be fairly set and grading of the benches on either bank can occur. Any rubble used as fill would be buried with soil. Earth moving equipment such as trackhoes, bulldozers, and other equipment would be used to grade the benches (See Section 3.1.1.2.2) such that they would have a more gradual slope along the sea wall and downstream to the access point. Grade ratio would depend on need at the time of restoration. Stabilization measures would be used to prevent erosion. These measures include seeding and vegetative strategies designed to control invasive plant colonization. A planting plan was designed, detailing a planting list (common name, Latin name, and wetland indicator) for each seed mixture species and the estimated seeding rate (FEIS Appendix A6). The planting plan will be part of the Section 404/401 Clean Water Act permit application and water quality certification process. Construction plans would include the planting plan, which details planting zones, cost estimates, environmental covenant, and plant species list to be used.

Information regarding in-kind-mitigation is discussed in the planting plan and a commitment to reforest the site by planting bare root saplings and containerized trees is made (FEIS Appendix A6). However, the objective of the planting plan is to stabilize the site and combat the proliferation of reed canary grass. This would provide the seed bank the opportunity to propagate forest succession. All disturbed areas would be replanted with the exception of the north access road. This access point would be maintained by the City for routine ICS maintenance and potentially a recreation access point in the future.

As restoration is being completed, removal of the remaining temporary ramp from Phase 2B would occur. Access to the river for motorized vehicles would be controlled by a gate. Additionally, the south abutment access road from Phase 1A would also be restored to conditions prior to construction.

3.1.1.3 Phase 3 – Sea Wall modification and restoration of the impoundment area

3.1.1.3.1 Phase 3A – Monitoring Channel Restoration and Water Supply Intake (Approximately Summer 2018)

As Phase 2D is being completed, monitoring of the City's reservoir intake, approximately 1.5 river miles (2.4 river kilometers) upstream of the dam, would occur to ensure that, during the lowering of the impoundment, no sediment blockage occurs due to instability of upstream banks. Similarly, stability of River Road would be monitored (just southwest of the intersection of River Road and Buckland Avenue) to ensure that no impacts to infrastructure occur as a result of the pool drawdown. If stabilization is necessary, appropriate measures would be implemented to safeguard both the intake and roadway.

3.1.1.3.2 Phase 3B – Remove any remaining dam material and modify seawall (Approximately August-November 2018)

After Phase 3A, any material stockpiled in the staging area or along the access road would be removed from the site. The temporary work area gating would be removed and permanent gate and appropriate signage installed limiting access to the project restoration area.

Additionally, in this phase, the sea wall would be modified. The wall is approximately 702 feet (214 meters) long and 1.5 feet (0.5 meters) wide with an average height of five feet (1.5 meters). The sea wall would be reduced in height, mechanically, to grade while keeping the below-grade portion in place. Approximately 195 CY of concrete would be removed and disposed of appropriately. Any rebar or other reinforcement would be cut flush with the remaining base. A permanent fence would then be placed atop of the remaining wall for safety, to prevent members of the public from falling from the top of the sea wall to the riverbank below. Upon modification of the sea wall and installation of the fencing the project would be completed. Phase 3C would be initiated, if necessary, after completion of Phases 1 through 3B.

3.1.1.3.3 Phase 3C – Remove Tucker Dam – if necessary (Approximately Fall 2018)

Removal of Ballville Dam and pool is expected to expose the Tucker Dam, if present, either whole or in part. The initial notch of the dam in Phase 1B would lower the impoundment to the point where evidence regarding whether the dam may still be in place and its potential to impact the success of the Proposed Action could be determined. If the Tucker Dam is intact and requires action, the Programmatic Agreement between the Service, Consulting Parties, and the OHPO provides guidance for removal based on its disposition (FEIS Appendix D1). If Phase 1B provides evidence of the structures existence then it would be assessed in order to delineate concerns for safety and effectiveness of the restoration based on its presence. An adaptive strategy may be necessary to assess if removal should occur prior to Phase 3C. If removal is necessary, best management practices would be employed to remove the structure.

3.1.1.3.4 Phase 3D – Monitoring and Adaptive Management (Multi-year)

The final phase of the project would occur for multiple years post-removal and would involve monitoring and adaptive management. Monitoring of wetland formation, areas of erosion and deposition, water quality, fish diversity and movement, and mussel relocations would occur to document ecological impacts of dam removal as well as compliance with Section 10/401/404 permits from the USACE and OEPA. Adaptive management could include shaping the floodplain topography to promote the formation of fringe wetlands and/or floodplain wetlands, addressing rilling or gully formation on exposed sediments upstream of the dam, excavation near the reservoir intake to improve flow, or other adaptive actions to address erosion or habitat enhancements as upstream river conditions change.

3.1.1.4 Proposed Action Estimated Cost Opinion

The Proposed Action would remove the Ballville Dam in three distinct phases, as discussed above. Construction cost opinion is approximately $3.6 million with a 20 percent contingency

(Table 3-1). Operation and maintenance costs add an additional $400,000. When considering all aspects of the Proposed Action the total cost opinion is $6,288,216. Additional costs may be incurred if compensatory mitigation for wetland impacts is required as a result of the USACE Section 404/10 permitting process for this alternative. The need for additional compensatory mitigation has not yet been determined, thus a cost estimate has not been generated yet nor included here. There are $2 million awarded by the Service through the GLFWRA to ODNR and approximately $5.8 million awarded by OEPA through the WRRSP program available to carry out this alternative.

Table 3-1. Proposed Action Estimated Cost Opinion

No.	Item	Total Cost
Construction Phase		
1	Mobilization / Demobilization (~5%)	$150,000
2	Portable Sanitation Units	$4,000
3	Project signs	$5,000
4	Stabilize construction access w/culverts	$100,000
5	Concrete hoe-ramming	$1,822,500
6	Concrete Disposal	$126,000
7	Loading out concrete for disposal	$105,000
8	Hauling concrete off site	$52,500
9	Channel tuning with excavator	$60,000
10	Erosion control barrier	$8,000
11	ICS Coffer dam for water diversion	$56,250
12	Floodplain protection (rock or wood bollards)	$12,000
13	ICS Dewatering pump/treatment system	$60,000
14	ICS caissons	$380,000
15	ICS Caisson rock excavation	$353,400
16	ICS Caisson rig mob/demob.	$36,000
17	Steel Reinforcing	$227,130
18	Topsoil	$21,000
19	Plantings (1 gal)	$25,000
20	Plantings (bare-root seedlings)	$4,000
21	Soil conditioning (limestone)	$1,000
22	Seeding (mechanical)	$60,000
23	Seeding (manual)	$2,500
24	Erosion Control Blanket	$18,900
	Total Construction:	**$3,690,180**
	Construction Contingency (20%)	**$698,036**
Operation and Maintenance (O & M)		
1	North Abutment and Carbon Feed	$200,000

Table 3-1. Proposed Action Estimated Cost Opinion

No.	Item	Total Cost
2	Bank Stabilization	$200,000
	Total O & M Cost:	**$400,000**
Design and Permitting		**$1,100,000**
	Total Dam Removal Costs:	**$6,288,216**

3.1.1.5 Proposed Action Summary

Removal of the Ballville Dam, and Tucker Dam if needed, over a multi-event period would meet the purpose and need for the project. It would provide fish passage in both directions, restore system connectivity and many natural hydrologic processes in the lower Sandusky River, help balance sediment loads, as well as eliminate the liabilities associated with maintaining the existing structure and achieve biological use attainment for this section of the Sandusky River.

3.1.2 Alternative 1 – No Action Alternative

This FEIS requires analysis of a "no action alternative" for comparison with other action alternatives. Under this alternative, federal funding would not be provided to remove the structure. Instead, it is expected that the Ballville Dam would remain in place and require extensive rehabilitation to be compliant with ODNR dam safety standards. The ARCADIS (2005) investigation report provided findings regarding methods and cost estimates to rehabilitate the Ballville Dam. In November 2013, the Mannik and Smith Group (MSG) provided an investigation report that updated the findings and cost estimates for rehabilitation of the Ballville Dam based on the 2005 ARCADIS report. The No Action Alternative is based on conclusions and recommendations provided in these reports.

Below are the expected rehabilitation items included in the No Action Alternative. Table 3-2 provides a depiction of where primary rehabilitation would occur.

3.1.2.1 Lake Drain

The "lake drain" refers to the sluice gates on the dam. Six gates were originally built, but after the 1969 modification only two remained operational. In 1980, the ODNR found one sluice gate was inoperable and the other was leaking to some degree (ODNR 1981). In order to repair concrete deteriorations on the dam, the water level on the impoundment would need to be lowered by opening the sluice gate(s). In order for the sluice gates to be opened, they must first be repaired. Additionally, it is required for dam safety that these gates be operable (ODNR 2004). The probable costs of construction include costs for marine equipment and labor for sluice gate rehabilitation (ARCADIS 2005 and MSG 2013).

Design of the "lake drain" repair is not complete. It is anticipated that an area around the sluice gates would be dewatered by use of coffer dams around the gate area to minimize any sediment release from the replacement. This would enable rehabilitation or replacement to be conducted “in the dry” to eliminate influence of sediment stores and hydraulic pressure.

3.1.2.2 Concrete Repairs

Considerable concrete deterioration has occurred on the dam; especially in those areas that were repaired in 1969. Additionally, there is some limited scour beneath the toe of the spillway sections and central non-overflow section that require filling. ARCADIS (2005) found these conditions nonthreatening to water retaining structures, but recommended their repairs for long term serviceability of the dam. In 2013, MSG found these conditions continuing to deteriorate. Specific detail and location where concrete repairs are needed are discussed in the No Action Alternative Memo (FEIS Appendix A7). The primary items are:

- Replacement of shotcrete on the left abutment downstream training wall;
- Replacement of shotcrete on all surfaces of the central non-overflow walls;
- Installation of formed concrete at the downstream end of the central non-overflow section and base of the training wall next to the left spillway and non-overflow section to fill scoured voids below the current forms;
- Filling of the void under the toe of the right spillway section;
- Installation of steel angles on the upstream corners of the raw water intake for protection; and
- Injection of epoxy into cracks in the left side of the central non-overflow section.

There are several options for replacement of concrete. Replacement of shotcrete would be accomplished by removing all loose material, cutting the void edges with a saw, using anchoring wire mesh in the void, and reapplication of shotcrete. This repair would not be permanent but would likely last approximately 30 years based on previous environmental conditions. A second option to improve concrete conditions would be the application of a polymer modified concrete that has enhanced adhesion properties for reduction in permeability. Polymer modified concrete would likely have a longer lifespan than shotcrete and extend repair life to 50 years (MSG 2013).

The filling of voids along the downstream toe would require preparation of the surface by cutting the edges and installing wire mesh that is securely anchored to the prepared surface. In order to fill below the waterline, polymer modified concrete would be tremied in the wetted conditions to fill the void. Installation of formed concrete at the downstream end of the central non-overflow section and at the base of the training wall next to the left spillway and non-overflow section would be completed at the same time and forms used to fill voids.

ARCADIS (2005) noted that steel plating was used below the water line for protection against debris impact into the structure prior to falling over the spillway. Installation of similar steel plating would be used to help reduce continued deterioration. Installation would require replacement of the shotcrete (as described above) and then securing steel plates along the corners with drilled shafts for large welded rebar/steel bars.

Injection of the epoxy into cracks would require surface preparation and cleaning and then injection of the epoxy for filling. This action would help prevent these areas from further deterioration from thaw/freeze and other environmental conditions.

Construction access to the structure for filling voids and other repairs and rehabilitation was not specifically described in either report. Access to rehabilitate the downstream side of the dam is likely to require development of an access point along the northern bank similar to that described in the Proposed Action. Access to the upstream rehabilitation areas may occur via upstream barge or from atop the dam. These are only a couple of the possibilities. Prior to initiation of rehabilitation, the City and its selected contractor would develop specific plans for access.

3.1.2.3 Sea Wall

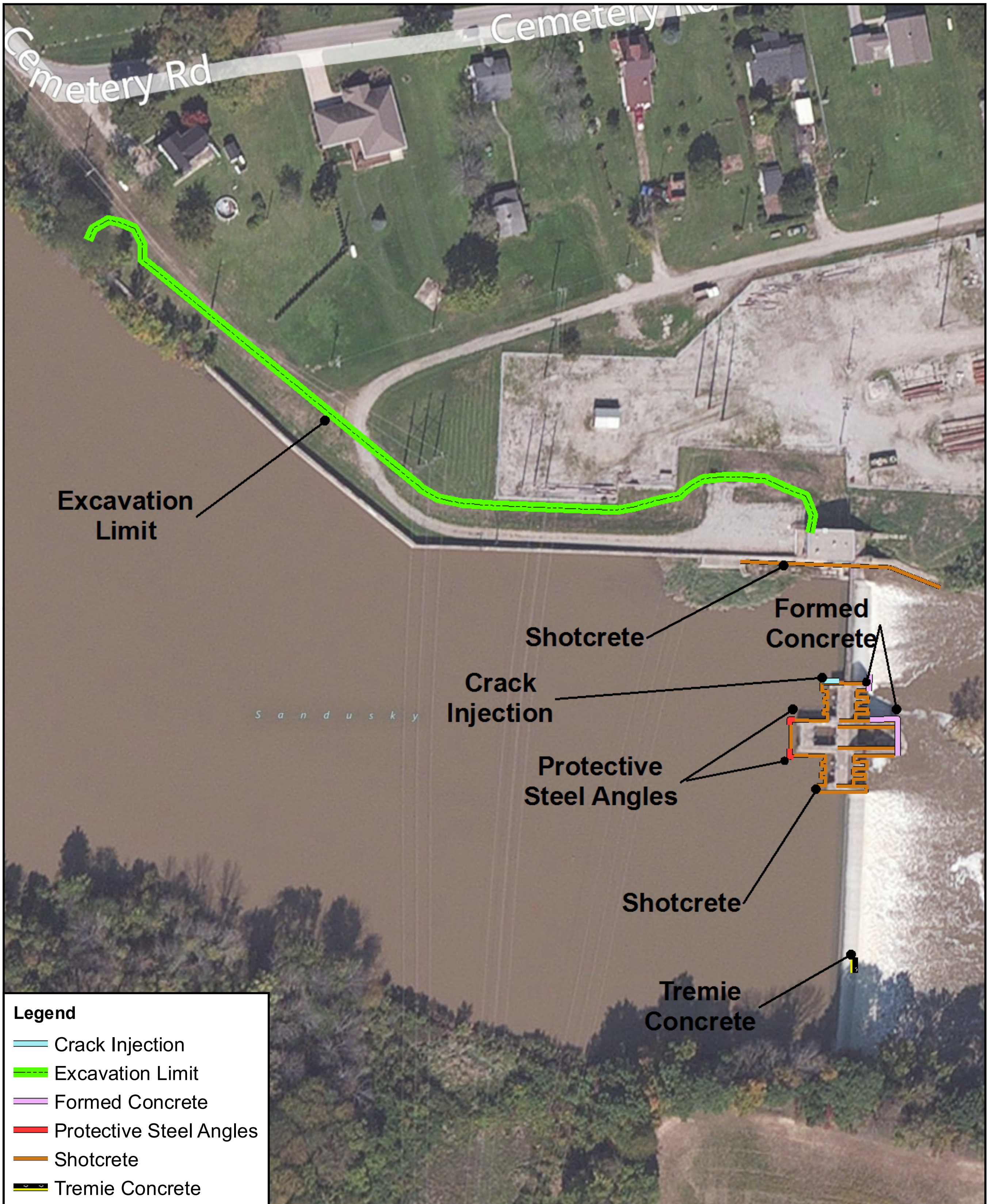
The sea wall was found by ARCADIS (2005) to be at risk of failure in floods that would crest the wall (>50,000 cfs). The overflowing water would erode the backfill and possibly cause collapse. Vegetation behind the seawall is maintained grass with no trees or other deep rooted vegetation. This is similar to the condition that destroyed the dam during construction in 1911. Two solutions were developed in order to prevent the sea wall from failing: a gravity alternative and a post-tension alternative.

The gravity alternative would remove the soil behind the sea wall down to rock and replace it with a non-erodible material that would remain stable during a cresting of the wall. ARCADIS (2005) proposed roller compacted concrete (RCC) or rock fill consolidated with grout as possible materials. The No Action Alternative Memo provides a typical cross section using the gravity alternative (FEIS Appendix A7).

The second alternative for addressing the sea wall stability is the post-tension alternative. This alternative requires the installation of post-tensioned anchors in the sea wall. This alternative assumes that the concrete in the existing seawall is suitable and that subsurface rock is capable to resist the anchor loads. Extensive geotechnical investigation of both the subsurface rock and the sea wall would be necessary to confirm the feasibility of this alternative. The No Action Alternative Memo provides a typical cross section using the post-tensioned alternative method (FEIS Appendix A7).

3.1.2.4 Operational Manuals

In order to bring the dam into compliance, two documents would be developed: 1.) an operations, maintenance, and inspection manual; and 2.) an emergency action plan. These documents would provide discussion of the various modifications and utilize the results of hydrology and hydraulics modeling.



Basemap: BING

No Action Alternative 1; Primary Areas of Rehabilitation

Ballville Dam Project

0 60 120 Feet

Figure 3-2

3.1.2.5 No Action Alternative Estimated Cost Opinion

In 1980, the ODNR identified deficiencies with the Ballville Dam that has been recommended for repair and rehabilitation. Currently, the dam and sea wall are not operating in accordance with ODNR safety standards. The table below provides estimated opinion of costs for rehabilitation of the dam to meet ODNR standards based on the revised cost estimates from MSG (2013). The No Action Alternative ranges from $8.9 to $10.7 million based on 2013 estimates (Table 3-2). The increase concrete repair costs from 2005 are based on differences in the design and administration of construction. These costs are approximately $4.9 to $5.6 million more than estimates prepared in 2005. Details of the opinion of costs are presented in the No Action Alternative in FEIS Appendix A7.

Cost estimates varied between 2005 and 2013 based on, but not limited to, the following: method of concrete rehabilitation, increase in rehabilitation amounts needed, pricing of concrete removal, increase in overall material costs, mobilization increases, other items not previously considered, increase in design and construction engineering and administration that are likely to be realized (MSG 2013).

There are no funds available from the Service or OEPA to carry out this alternative. The City has indicated that increases in the cost of water rates for the local community may be required to carry out this alternative. There is also the potential for repayment of $5 million dollars from the City to ODNR related to an agreement identified during project scoping (see Section 2.1.2 of the FEIS).

Table 3-2. No Action Alternative Estimated Cost Opinion

Item	Costs
Concrete Repairs	$6.4 Million
Sea Wall Stabilization	
Gravity Alternative	$2.4 Million
Post-tension Alternative	$4.2 Million
Operational Manuals	$33 Thousand
Total Estimated Costs*	$8.9 - $10.7 Million

Source: Mannik & Smith Group 2013; ARCADIS 2005

3.1.2.6 No Action Alternative Summary

Repair and maintenance of Ballville Dam do not meet the purpose and need for the project. This alternative would correct the progressive deterioration of the dam and associated sea wall to comply with state-mandated dam safety requirements however it would not provide fish passage, restore system connectivity or natural hydrologic processes in the lower Sandusky River, or eliminate the liabilities associated with maintaining the existing structure in perpetuity.

3.1.3 Alternative 2 – Rehabilitate dam, install Fish Passage Structure

Alternative 2 outlines the rehabilitation and continued maintenance of Ballville Dam, bringing it into compliance with relevant safety and operation standards, as described in detail in Alternative 1, but also includes the construction of a fish elevator structure to allow for upstream movements of native fish species. The ARCADIS (2005) investigation report, with new information from the 2013 MSG report, are the most current assessment available for the Ballville Dam; therefore, this alternative is based, in part, on conclusions and recommendations provided in those reports as described in Section 3.1.2. The ARCADIS (2005) report presented several remediation needs for the dam and sea wall. These same repairs as described in Alternative 1 would also be implemented in Alternative 2 to rehabilitate the dam prior to installation of a fish elevator system.

3.1.3.1 Fish Passage Design and Operational Requirements

Primary design components of the fish elevator would be constrained by the need for continuous mechanical operations during seasonal migration periods to provide for upstream fish passage. Typical components of a fish elevator include 1) siting at an appropriate location along the downstream side of the dam, 2) provisions for suitable attraction flow to guide fish into the inlet, 3) a trap system, 4) a lifting system, 5) sorting system, and 6) a fishpass outlet. General concepts for these six components are described below. Figure 3-3 provides a conceptual layout of what a fish elevator system may look like at the Ballville Dam.

3.1.3.1 Design Criteria for Ballville Dam

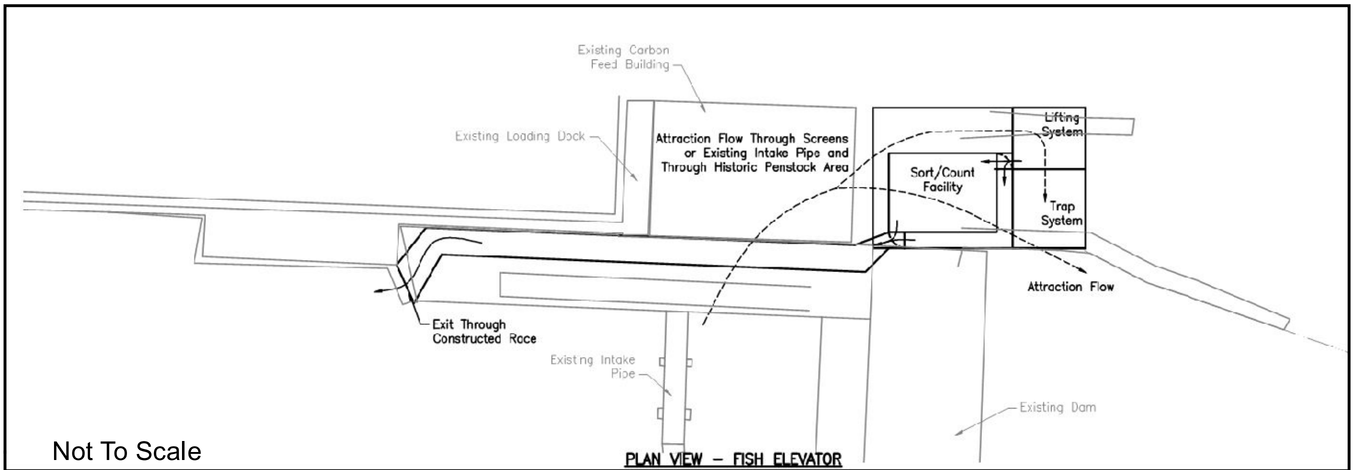
The objective of a fish elevator system would be to provide for upstream passage of fish that are commercially and ecologically important in the Sandusky River. Those fish species at Ballville Dam include Walleye, White Bass, and Greater Redhorse. A fundamental component of a fish elevator system at Ballville Dam is trapping of fish prior to lifting the elevator component for release upstream. Fish elevators do not provide for volitional upstream fish passage. The provision for trapping fish and allowing for exclusion of undesirable and/or invasive species such as Sea Lamprey (*Petromyzon marinus*) and Asian Carp is one benefit of the system.

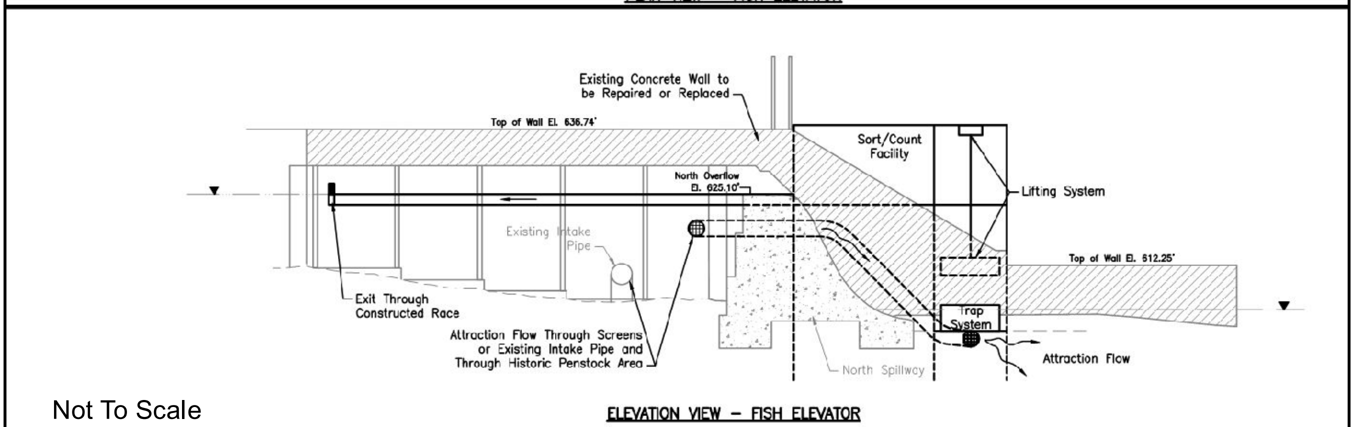
Peak migration periods for three target fish species for upstream passage at Ballville Dam are presented in Table 3-3 along with seasonal flow statistics developed as part of the Ballville Dam Removal Feasibility Study (Stantec 2011). A fish elevator system is not necessarily as constrained as a flow-through fish passage system (e.g. fish ladder) by low and high flow conditions, and, conceptually, may function at a broader range of flows relative to a flow-through system. However, fish must be able to reach the entrance to the fish elevator system and must be able to successfully exit the system and proceed upstream.

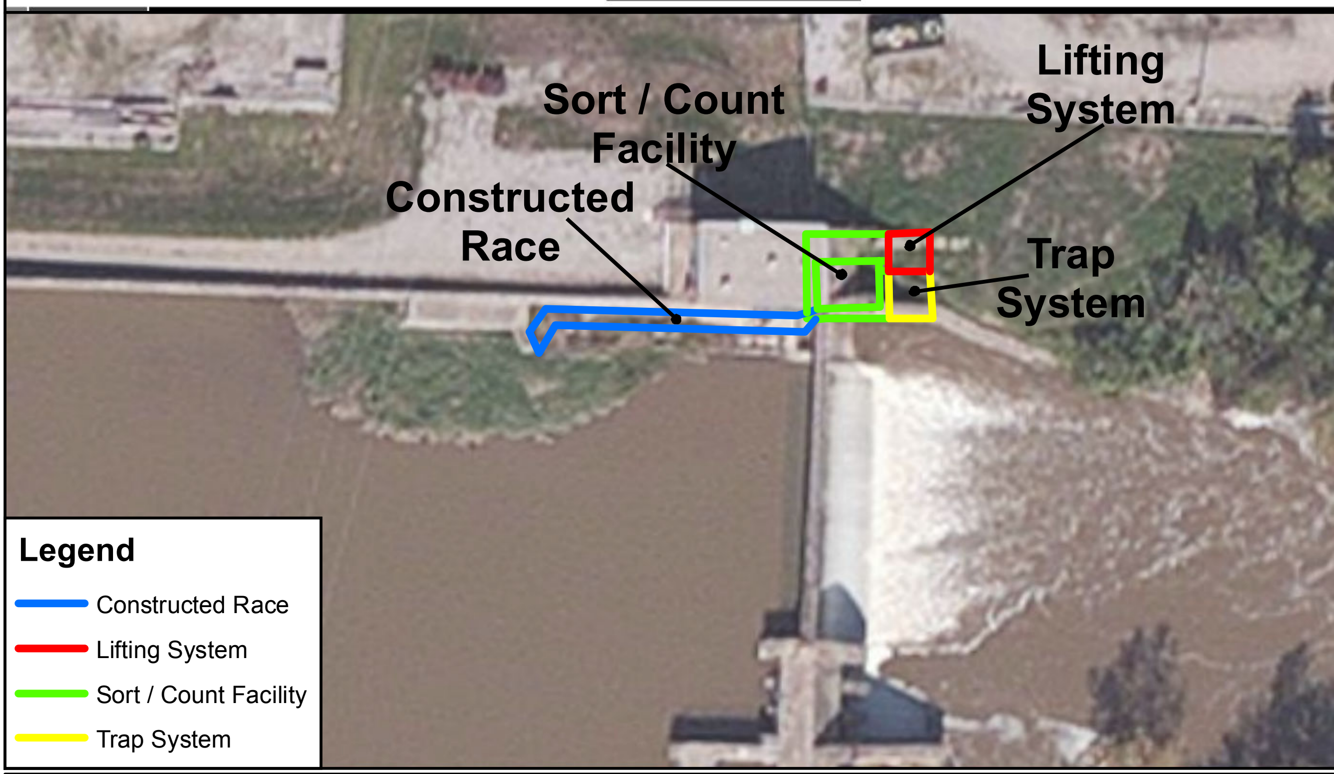
Table 3-3. Seasonal Migration and Staging Periods for Target Fish Species

Fish Species	1-Mar	15-Mar	1-Apr	15-Apr	1-May	15-May	1-Jun	15-Jun
Walleye								
White Bass								
Greater Redhorse								
	Monthly Hydrologic Statistics (cfs)							
Flow Statistic	March		April		May		June	
75% Exceedance	510		467		288		156	
Median	954		1020		476		341	
25% Exceedance	2,490		2,400		1,075		800	

= Low-Level Activity
= Peak Activity







Basemap: BING

Fish Elevator System Conceptual Design

N
W E
S

Ballville Dam Project

0 30 60 Feet

Figure 3-3

The commercially and ecologically important species in the project area typically spawn between March and mid-June; therefore, the fish elevator would be active during this period of the year to allow fish to move upstream to spawn. The system would not be operated during other parts of the year. A review of stream gauging data for that period showed that median stream flow ranged between 341 and 954 cfs (Table 3-3). For design purposes it was assumed that upstream fish passage was optimal between the 75th and 25th exceedance percentiles. Thus the range of flows during which a fish elevator at Ballville Dam would provide for safe, timely, and effective upstream fish passage for the target fish species ranged from approximately 150 to 2,500 cubic feet per second (cfs).

3.1.3.1.1 Siting

The area adjacent to the left abutment of the dam appears to be generally suitable for installation of a fish elevator. A primary requirement is that the structure be located where it is not subject to damage from flow passing over the north spillway and can be generally seen on Figure 3-3.

3.1.3.1.2 Attraction Flow

Attraction flow would be necessary to guide fish into the trap entrance at the base of the fish elevator. The entrance would likely be an opening in the existing wall large enough to allow for fish to enter the elevator system. The general configuration of this system would be similar to a flow-through fishpass. The design of the attraction flow would consider information on hydraulic conditions in the area immediately downstream from the north spillway and further downstream. Selection of an appropriate attraction flow discharge and orientation of the attraction "jet" at the base of the dam would be based on flows during the seasonal upstream passage period(s). The attraction flow would be parallel to the retaining wall that extends downstream from the north abutment of the dam.

The volume and jet velocity of the attraction flow depend on a variety of factors; a conceptual estimate of total attraction flow is 50 cubic feet per second (cfs), comprised of 25 cfs discharged through the trap system and 25 cfs of augmented attraction flow discharged into the plunge pool in the immediate vicinity of the trap inlet. Both the trap system and augmentation flow would be provided using conduits from the upstream impoundment with appropriate controls and fittings (e.g., valves, diffusers).

Given the general unsuitability of the Ballville Dam to direct fish to the plunge pool immediately downstream from the north spillway, modifications of the downstream channel may be appropriate to guide fish to the fish elevator facility if it is deemed necessary based on post project monitoring and passage success.

3.1.3.1.3 Trap System

The trap system would be located upstream from the fishpass entrance. In general, the trap would be similar to a fyke net; with fish passing through a narrowing slot prior to entering the trap that is part of the lifting system. Attraction flow (assumed here as 25 cfs) would be routed through the trap system. A temporary closure fence would be used at the inlet of the trap; this fence would be closed prior to lifting and reopened upon completion of a lifting cycle when the trap is returned to the bottom of the trap well.

3.1.3.1.4 Lifting System for Fish Passage Structure

The lifting system would be comprised of a “lift bucket” to allow fish to be persistently wet during vertical transport. The lift bucket would have a minimum internal dimension of at least 4 feet by 6 feet by 2 feet (1.2 by 1.8 by 0.6 meters). This would allow the volume of water in the lift bucket to be sufficient and limit the potential for asphyxiation of fish due to oxygen depletion during lifting. The lift speed would be 0.5 feet/second (0.2 meters/second) to a lift height of 30 feet (9.1 meters), the duration of lifting would be 60 seconds.

The conceptual lift bucket volume would be 48 cubic feet (approximately 360 gallons [1,362.8 liters], 3,000 pounds [1,360.8 kilograms]). Screening along the side would allow for draining-off of water during lifting and containment of fish.

To avoid potential system failure and release of fluids as a result of hydraulic leaks or bursts, a mechanical chain hoist or winch system would be used for lifting the bucket. The fish elevator would be cycled (up and down) approximately every 15 minutes. This allows for the sorting station to complete its task between lift cycles. During periods when numbers of migrating fish are low, filling of the trap would represent a limiting factor on cycle time.

3.1.3.1.5 Sorting System

Exclusion of undesirable species would be part of fish elevator operation at Ballville Dam. Removal and disposal of upstream migrating invasive species such as Asian Carp and Sea Lamprey, if present, would be required at the upstream fish elevator system on Ballville Dam. The construction of a trapping and sorting facility with a lift or lock system would facilitate part of the project. Such a facility would be best located at the fish elevator outlet. This system would include holding pools and means to effectively sort, capture, and dispose of undesirable and/or invasive species. The sorting system would be enclosed in a building so that sorting staff of one or more employees could sort fish without influence of the outside weather (i.e. temperature, precipitation, lightning hazards, etc.). The current carbon feed building would be adequate in size and position to support this facility.

3.1.3.1.6 Fishpass Outlet

The fishpass outlet would be located upstream from the north spillway. This structure would be designed and built to ensure fish can successfully move upstream from the fishpass outlet with minimal risk of being swept downstream and over the spillway. Most fishpass outlets are small concrete canals that extend upstream that allow for the fish to safely pass upstream without fighting current. At Ballville Dam, the outlet would direct fish to the Sandusky River approximately 100 feet (30.5 meters) upstream along the northern edge of the river.

3.1.3.2 Fish Passage Structure Alternative Estimated Cost Opinion

In 1980, the ODNR identified deficiencies with the Ballville Dam that has been recommended for repair and rehabilitation. Currently, the dam and sea wall are not operating in accordance with ODNR safety standards. The table below provides estimated opinion of costs for rehabilitation of the dam to meet ODNR standards as well as the addition of a fish elevator system. The Rehabilitate Dam and Install Fish Passage Structure Alternative ranges from $16.8 to $18.6 million based, in part, on 2013 estimates of rehabilitating the dam (Table 3-4). The concrete repair differences are based on differences in the design and administration of construction. Details of the opinion of costs are presented in the Rehabilitate Dam and Install Fish Passage Structure Alternative in FEIS Appendix A8.

There are no funds available from the Service or OEPA to carry out this alternative. The City has indicated that increases in the cost of water rates for the local community may be required to carry out this alternative. There is also the potential for repayment of $5 million dollars from the City to ODNR related to an agreement identified during project scoping (see Section 2.1.2 of the FEIS).

Table 3-4. Estimated cost for Fish Elevator System

No.	Item	Total Cost
Dam and Sea Wall Rehabilitation (ARCADIS 2005; MSG 2013)		
1	Concrete Repairs	$6.4 Million
2	Sea Wall Stabilization	
2a	*Gravity Alternative*	$2.4 Million
2b	*Post-tension Alternative*	$4.2 Million
3	Operational Manuals	$33 Thousand
	Total Rehabilitation	**$8.9 - $10.7 Million**
Construction of Fish Elevator System Phase		
1	Coffer dam	$150,000
2	Tailrace excavation	$250,000
3	Fishway foundation elements	$200,000
4	Steel superstructure (structural elements)	$225,000
5	Fishway controls (mechanical elements)	$175,000
6	Fishway attraction flow piping	$350,000
7	Volitional channel, control gate	$300,000
8	Construction phase engineering support	$90,000
9	Construction QA/QC	$120,000
	Total Construction:	**$1,860,000**
	Construction Contingency (30%)	**$558,000**

Table 3-4. Estimated cost for Fish Elevator System

No.	Item	Total Cost
Operation & Maintenance		
1	Annual Labor	$70,000
2	Annual Miscellaneous Maintenance	$5,000
3	Fishway Control Replacement (Annuitized over 15 years)	$17,500
4	Capitalized Cost* (assuming 2 percent interest per year)	$4,625,000
	Total Capitalized Operation & Maintenance Cost:	**$4,717,500**
Design and Permitting		
1	Additional Dam Safety Analyses	$150,000
2	Additional Subsurface / Geotechnical Exploration	$100,000
3	Design of fish elevator - Modeling and agency coordination	$100,000
4	Design of fish elevator - Structural	$150,000
5	Design of fish elevator - Mechanical	$80,000
6	Permitting	$200,000
	Total Dam and Sea Wall Rehabilitation	**$8.9 to $10.7 Million**
	Total Design and Permitting for Fish Elevator System:	**$780,000**
	Total Fish Elevator Costs:	**$7,915,500**
	Total Rehabilitation and Fish Passage Structure Costs	**$16.8 to $18.6 Million**

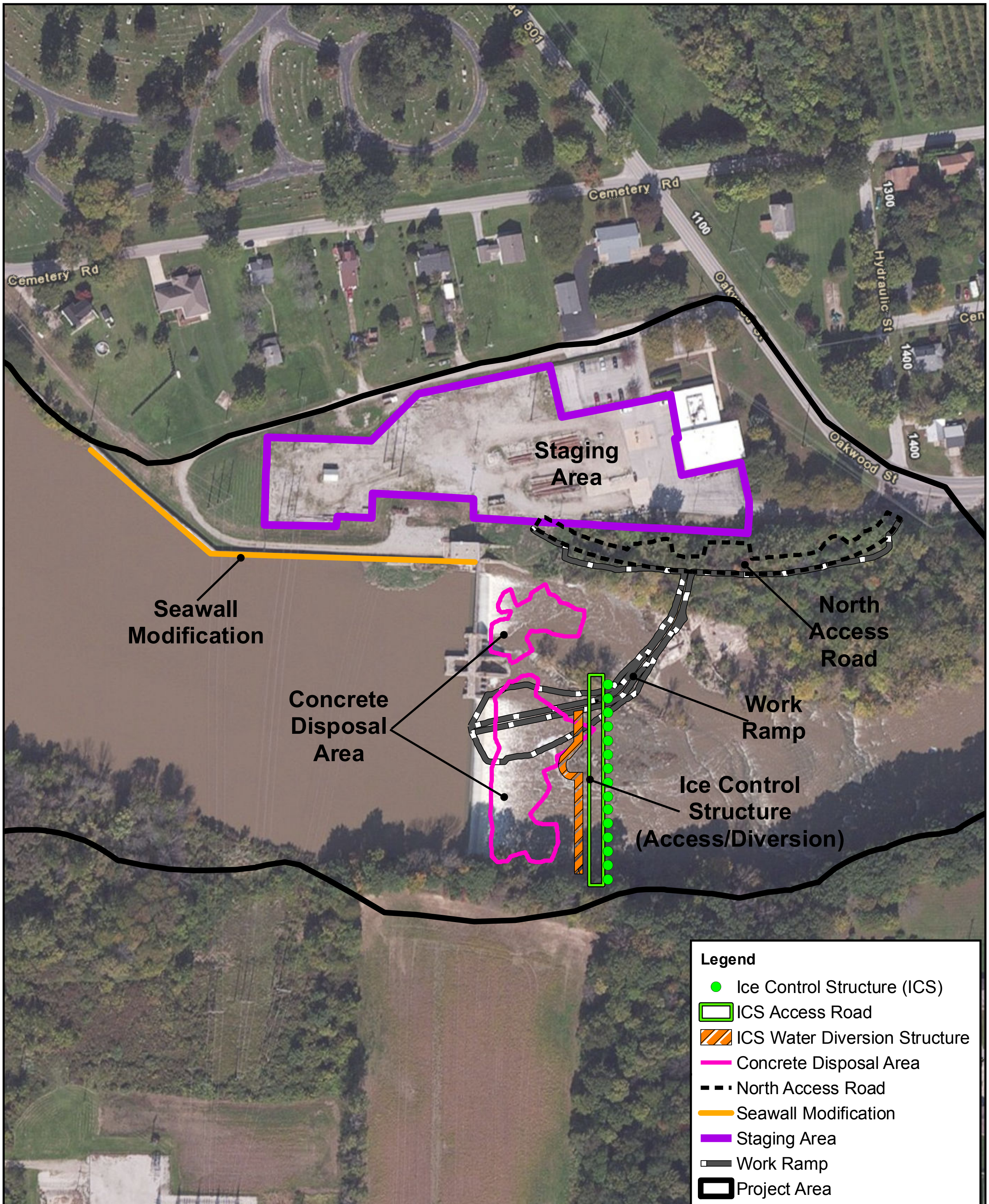
*Capitalized costs are those for future operation and financing of the fish elevator. These costs are captured in current year dollars.

3.1.3.3 Rehabilitate dam, install Fish Passage Structure Summary

A fish elevator structure would provide for potential movement of fish upstream of the existing Ballville Dam, and maintain the historical nature of Ballville Dam, but it does not meet the need for restoring system connectivity and natural hydrologic processes both below and immediately above the dam in the Sandusky River Watershed. While this alternative does not meet all aspects of the purpose and need for the project, it does provide a reasonable alternative for consideration. Table 3-4 provides estimated costs for rehabilitation of the dam and construction of the fish elevator structure.

3.1.4 Alternative 3 – Dam Removal with Ice Control Structure

Alternative 3 would be divided into two phases with each phase having multiple objectives for meeting dam removal goals. In summary, the phases are 1.) ICS construction, dam removal and restoration; and 2.) sea wall modification and restoration of impoundment area. Figure 3-4 provides location information for Alternative 3. Phases of demolition and construction are discussed in the following sections.



Basemap: ESRI

Alternative 3; Primary Area of Demolition and Construction

N W E S

Ballville Dam Project

0 400 800 Feet

Figure 3-4

3.1.4.1 Phase 1 – sediment stabilization, dam removal, and ICS construction

3.1.4.1.1 Phase 1A – Construct access ramp below dam (Approximately June – July 2017)

Demolition equipment would access the dam entirely from the north side of the Sandusky River using the American Electric Power (AEP) storage yard adjacent to the dam. Access to the construction site would be controlled by a lockable double swing gate placed on a temporary fence. Approximately 0.3 acres (0.1 hectares) of wooded riparian habitat would be cleared for development of the access road. The access road would be constructed of clean fill and crushed limestone. Some limited cut and fill would be necessary to meet grade specifications needed for construction traffic. The access road would be constructed to allow for dump trucks, bulldozers, and other construction equipment to access the worksite.

No refueling of equipment would occur within the Sandusky River. Refueling would only occur within the project staging area (in the AEP storage yard) in order to prevent fuel spills within the waterway. Once access to the river is established, a temporary work ramp would be constructed to allow access for equipment to reach the top of the south spillway (elevation 625 feet [190.5 meters]). The ramp would be approximately 250 feet (76.2 meters) in length and rise in elevation from 602 feet (183.5 meters) to 620 feet (189 meters) at the dam. Total volume of the ramp is estimated to be 7,400 CY of natural rock, crushed rock and concrete rubble. Maintenance of the ramp and access road within the banks of the Sandusky River may be more frequent than at the entry gates due to rise of water elevation during rain events. However, these are expected to be infrequent due to the location and elevation of the modified impoundment pool. Sediment and erosion control measures would apply as appropriate along the length of the access road and ramp. As demolition of the south spillway and non-overflow portion of the dam occur, the temporary access ramp would be lowered and/or placed in locations to help control grade of the new floodplain bench. The access road from County Road 501 to the work ramp would be removed after Phase 2B however the portion from County Road 501 through the wooded riparian area would remain in place for future access for removal of the debris from the ICS as well as future recreational access.

3.1.4.1.2 Phase 1B – Construct ICS (Completed[4] September – October 2016)

[4] Between the publication of the Draft SEIS and the publication of the Final SEIS, the City has constructed the ICS. This was completed from September through October of 2016 using their own funding under a separate 404 permit approved by the Corps. The Service has continued to work closely with the City of Fremont on this component of the project to understand its relationship to the Ballville Dam Project as a whole however the Service was not involved with ICS permitting or installation. ICS planning has been included in the EIS and SEIS documents for completeness and is again included here in the Final SEIS alternatives to depict the complete suite of actions. In the Proposed Action (Section 3.1.1) and in Alternative 3 (Section 3.1.4), ICS construction appears in Phase 2C and 1B respectively, however completing it first does not substantively change either alternative or how these alternatives are evaluated.

Access for construction of the ICS would be via the access road of Phase 2B, described above. Construction of the ICS would be located 175 feet (53.3 meters) downstream of, and parallel to, the dam. The ICS consists of 15 piers spaced 21 feet (6.4 meters) apart on centers. Overall, the piers would be 25 feet (7.6 meters) tall and six feet (1.8 meters) in diameter. Piers would be embedded approximately 15 feet into the bedrock and extend 10 feet above grade. Exposure above grade would vary based on river bed; however, piers would be uniform in top elevation at 610 feet (185.9 meters) (FEIS Appendix A5).
The installation of the ICS can be performed during modestly active flow conditions anticipated during the low flow annual periods. The Contractor would use best management practices to isolate drill cuttings and prevent concrete from entering the watercourse during installation of the piers. The Contractor would implement water management practices during the installation of the ICS piers to maintain flow in the Sandusky River.

The contractor will access the pier locations using equipment placed directly in the riverbed. During drilling and construction of the piers, river flow will be temporarily diverted around the immediate work area, thereby preventing drill cuttings and concrete from entering the watercourse. It is assumed the contractor will use a large track-mounted drill rig to core bedrock. Drill cuttings may be used onsite for the access ramp to the dam. Concrete for the ICS piers will be delivered from local suppliers using commercial rubber-tired transit mixers.

The riverbed in this area is exposed bedrock with a few areas covered or filled with fine and course sediment. The contractor may require further temporary leveling for equipment access and safe construction. Leveling material, such as sand and gravel, may account for approximately 50 cubic yards of temporary fill within the Sandusky River.

The contractor, in conjunction with the planned access ramp for the dam, would likely build a temporary access road parallel to the entire length of the ICS alignment (Figure 3-1). This road would facilitate access for smaller rubber-tired vehicles and be safer for workers on foot. The road would contain approximately 700 cubic yards of fill, mainly placed within the Sandusky River (540 cubic yards, 0.103 acres). Approximately 80 cubic yards would be placed within Jurisdictional Wetland 18 (0.019 acres) and 80 cubic yards in Wetland 6 (0.015 acres). The access road would be comprised of materials, such as large gravels and cobbles, capable of withstanding river flow. The road may have a low section to pass water flow over the access road surface. Alternatively, a number of conduits may be installed beneath the road to pass expected flows. River diversion may be local to each pier or installed to surround groups of piers as construction proceeds. River flow may be diverted partially, depending upon the location of the work. Flows through main channels would be split around pier worksites within the center of the channel. The particular system used to accomplish this would be the responsibility of the Contractor.

For ICS construction, the contractor would generally follow the below sequence:

1. Create a level access path for the construction equipment (or the equipment would travel on the exposed rock river bed) along the ICS alignment.
2. Install a river diversion system (coffer, water dams, etc.) in order to work “in the dry.”

3. Install drip pans/trays beneath equipment to catch oil and gas leaks.
4. Install a local diversion (sandbags, etc.) at each pier site to guard against cuttings and concrete from entering the water course. Deploy seepage sumps and pumps.
5. Upon completion of construction remove from the river bed any equipment, materials and placed fill.

Each pier would be constructed in three parts: drilling, reinforcement placement, and concrete placement by tremie method (pumping from the bottom up). Each shaft would be drilled approximately 15 feet into the bedrock. A truck mounted drill rig with a 6-foot (1.8 meters) diameter toothed core drum would remove 1 to 3 foot-long (0.3 to 0.9 meter) plugs of bedrock.

Each plug would be extracted and drilling continued until the required depth is attained. After drilling, reinforcement is added. Reinforcement would consist of a six foot diameter circular form and a mesh of rebar assembled for structural strengthening. A cylindrical form for the concrete would extend at least 12 feet above grade to elevation 610 feet (185.9 meters). Tremie concrete would be used to fill the form, displacing any collected water. The fill volume for each pier would be approximately 26 CY and would be comprised of steel reinforced concrete. The entire ICS (15 piers) would result in nearly 390 CY of poured concrete.

Equipment would be staged in the north staging area and refueled daily at this location. It is estimated that shaft construction, including drilling, reinforcement and concrete placement, could occur at a rate of one pier per day. Concrete placement is likely to occur in groups of five to 10 piers for concrete delivery efficiency. A concrete pump truck and an estimated 40 concrete mixing trucks (roughly three mixer loads per pier) would access the project area via the north access road. After the concrete has hardened the circular forms would be removed exposing the structure.

During the 50 to 75 year service life of the ICS, various maintenance activities would be required to extend each pier’s service years. Concrete may experience spalling and abrasion throughout its service life. These areas would be patched with Portland cement grout or epoxy. Routine inspection of the structures would be necessary to ensure that the reinforcement is not exposed and that the concrete is maintained.

Periodic removal of debris that may accumulate on the structure may be necessary. The modified access along the north bank would be kept clear of vegetation for periodical access to the ICS for clearing debris (i.e. limbs and trees) and maintenance.

3.1.4.1.3 Phase 1C – Remove dam (Approximately September – November 2017)

After completion of Phase 1A an access road would be in place to begin demolition of the remaining dam. However, it is not until near completion of Phase 1B that demolition would begin. An initial breach of the dam would allow for the impoundment to lower for approximately one week. Afterwards, demolition of the dam occurs until the dam is removed. Demolition of the dam was originally planned to stop at the north abutment where the current carbon feed building is located as described in FEIS Appendix A4. However, the City and their contractor may determine it prudent to remove the structure during this phase in the interest of public safety and structural integrity. Demolition is expected to take approximately three months to complete including removal of the Phase 1A access ramp.

Demolition of the dam would be accomplished by a trackhoe (or hoe ram) accessing the top of the dam from the north access way and notching a portion of the dam from elevation 625 to 615 feet (190.5 to 187.5 meters). This notch would allow for an initial dewatering of the impoundment. After a short period of time, the bottom elevation of the notch would be lowered from elevation 615 feet to 610 feet (187.5 to 185.9 meters). This would allow for additional impoundment drawdown to occur while the trackhoe/hoe-ram demolishes the top of the remaining south spillway. As the south spillway is demolished, additional equipment would work to demolish the non-overflow section of the dam and move northward to demolish the north overflow area. Debris from the demolition would be directed to fall into a two large scour holes downstream of the south spillway and north overflow. The access ramp constructed in Phase 1A would be removed as the dam is reduced in elevation.

The Ballville Dam structure is constructed of approximately 15,000 CY of reinforced concrete consisting of clean concrete materials (approximately 14,000 CY) made from sand and gravel river materials and approximately 800 to 1,000 CY (loose) of steel rebar. During demolition, the contractor would be instructed to only permanently fill with unreinforced concrete into the designated disposal areas (i.e. scour holes). This would require the contractor to separate the steel rebar for offsite disposal. The separation process involves breaking up the larger concrete materials into boulder to cobble size rubble using a jack hammer or hoe-ram and separating the different materials using a claw, front loader, or bull dozer. A bulldozer may be used to push and spread the clean fill materials. An estimated 1,000 CY (loose) of steel rebar and unseparated concrete (i.e. tangled within the rebar) would be hauled offsite for disposal. The cost of hauling would be approximately $10,000.00 (estimated $10.00 per CY). The entire volume of debris from demolition of the dam is estimated to be 15,000 CY. Some of the metal materials in the dam such as the old penstock, sluice gates, and raw water intake apparatus would be removed from the demolition area upon extraction. Approximately 1,900 CY of clean concrete rubble fill from the demolition would remain in the two concrete disposal areas (scour holes) in order to level the river bed. The remainder of the clean material would be utilized during Phase 2E – Channel Restoration (See Section 3.1.1.2.5).

If the carbon feed building is demolished, it would be demolished using a claw, front loader, or bull dozer. All of the demolition materials would be hauled offsite for disposal.

3.1.4.1.4 Phase 1D – Channel restoration (Approximately December 2017)

After demolition of the dam, channel restoration would occur. Restoration of the project area would include approximately 28,000 CY of fill consisting of offsite rock and soil materials as well as some concrete rubble from the demolished dam and leftover access ramp. Any rubble used as fill would be buried with soil. Earth moving equipment such as trackhoes, bulldozers, and

other equipment would regrade the north bank into a more gradual sloping bank. Stabilization measures would be used to prevent erosion. These measures include seeding and vegetative strategies designed to control invasive plant colonization (FEIS Appendix A6).
As restoration is being completed, removal of the remaining temporary ramp from Phase 1A would occur. Minimal permanent access to the river for maintenance of the ICS would remain. Access to the river for motorized vehicles would be controlled by a gate.

3.1.4.2 Phase 2 – Sea Wall modification and restoration of the project area

3.1.4.2.1 Phase 2A – Monitoring Channel Restoration and Water Supply Intake (Approximately Summer 2018)

As Phase 1D is being completed, monitoring of the City's reservoir intake, approximately 1.5 river miles (2.4 kilometers) upstream of the dam, would occur to ensure that, during the lowering of the impoundment, no sediment blockage occurs due to instability of upstream banks. Similarly, stability of River Road would be monitored (just southwest of the intersection of River Road and Buckland Avenue) to ensure that no impacts to infrastructure occur as a result of the pool drawdown. If stabilization is necessary, appropriate measures would be implemented to safeguard both the intake and roadway.

3.1.4.2.2 Phase 2B – Remove any remaining dam material and modify seawall (Approximately October –December 2018)

After Phase 2A, any material stockpiled in the staging area or along the access road would be removed from the site. The temporary gating would be removed and permanent gate and appropriate signage installed limiting access to the project restoration area.

The last action of the project is to modify the sea wall. The wall is approximately 702 feet (214 meters) long and 1.5 feet (0.5 meters) wide with an average height of five feet. The sea wall would be reduced in height, mechanically, to grade while keeping the below-grade portion in place. Approximately 195 CY of concrete would be removed and disposed of appropriately. Any rebar or other reinforcement would be cut flush with the remaining base. A permanent fence would then be placed atop of the remaining wall to prevent falls from the top of the riverbank. Upon modification of the sea wall and installation of the fencing the project would be completed from a dam removal perspective.

3.1.4.2.3 Phase 2C – Remove Tucker Dam – if necessary (Approximately Fall 2017)

Removal of Ballville Dam and pool is expected to expose the Tucker Dam, if present, either whole or in part. The initial notch of the dam in Phase 1C would provide evidence regarding whether the dam may still be in place and its potential to impact the success of the Alternative 3. If the Tucker Dam is intact and requires action, the Programmatic Agreement between the Service, Consulting Parties, and the OHPO provides guidance for removal based on its disposition (FEIS Appendix D1). If Phase 1C provides evidence of the structures existence then it would be assessed in order to delineate concerns for safety and effectiveness of the restoration based on its presence. An adaptive strategy may be necessary to assess if removal should occur prior to Phase 2C. If removal is necessary, best management practices would be employed to remove the structure.

3.1.4.2.4 Phase 2D –Monitoring and Adaptive Management (Multi-year)

The final phase of the project would occur for multiple years post-removal and would involve monitoring and adaptive management. Monitoring of wetland formation, areas of erosion and deposition, water quality, fish diversity and movement, and mussel relocations would occur to document ecological impacts of dam removal as well as compliance with Section 10/401/404 permits from the USACE and OEPA. Adaptive management could include shaping the floodplain topography to promote the formation of fringe wetlands and/or floodplain wetlands, addressing rilling or gully formation on exposed sediments upstream of the dam, excavation near the reservoir intake to improve flow, or other adaptive actions to address erosion or habitat enhancements as upstream river conditions change.

3.1.4.3 Dam Removal with Ice Control Structure Alternative Estimated Cost Opinion

Alternative 3 would remove the Ballville Dam in two phases, as discussed above. Construction cost opinion is approximately $3.6 million with a 20 percent contingency (Table 3-5). Operation and maintenance costs add an additional $400,000. When considering all aspects of the Proposed Action the total cost opinion is $6,288,216. Additional costs may be incurred if compensatory mitigation for wetland impacts is required as a result of the USACE Section 404/10 permitting process for this alternative. The need for additional compensatory mitigation has not yet been determined, thus a cost estimate has not been generated yet nor included here. There are $2 million awarded by the Service through the GLFWRA to ODNR and approximately $5.8 million awarded by OEPA through the WRRSP program available to carry out this alternative.

Table 3-5. Proposed Action Estimated Cost Opinion

No.	Item	Total Cost
Construction Phase		
1	Mobilization / Demobilization (~5%)	$150,000
2	Portable Sanitation Units	$4,000
3	Project signs	$5,000
4	Stabilize construction access w/culverts	$100,000
5	Concrete hoe-ramming	$1,822,500
6	Concrete Disposal	$126,000
7	Loading out concrete for disposal	$105,000
8	Hauling concrete off site	$52,500
9	Channel tuning with excavator	$60,000

Table 3-5. Proposed Action Estimated Cost Opinion

No.	Item	Total Cost
10	Erosion control barrier	$8,000
11	ICS Coffer dam for water diversion	$56,250
12	Floodplain protection (rock or wood bollards)	$12,000
13	ICS Dewatering pump/treatment system	$60,000
14	ICS caissons	$380,000
15	ICS Caisson rock excavation	$353,400
16	ICS Caisson rig mob/demob.	$36,000
17	Steel Reinforcing	$227,130
18	Topsoil	$21,000
19	Plantings (1 gal)	$25,000
20	Plantings (bare-root seedlings)	$4,000
21	Soil conditioning (limestone)	$1,000
22	Seeding (mechanical)	$60,000
23	Seeding (manual)	$2,500
24	Erosion Control Blanket	$18,900
	Total Construction:	**$3,690,180**
	Construction Contingency (20%)	**$698,036**
Operation and Maintenance (O & M)		
1	North Abutment and Carbon Feed	$200,000
2	Bank Stabilization	$200,000
	Total O & M Cost:	**$400,000**
Design and Permitting		**$1,100,000**
	Total Dam Removal Costs:	**$6,288,216**

3.1.4.4 Dam Removal with Ice Control Structure Summary

Removal of the Ballville Dam, and Tucker Dam if needed, during a single event would meet the purpose and need for the project. It would provide fish passage in both directions, restore system connectivity and natural hydrologic processes in the lower Sandusky River, help achieve aquatic life habitat use-attainment, as well as eliminate the liabilities associated with the existing structure.

3.2 SUMMARY OF KEY ELEMENTS OF ALTERNATIVES CARRIED FORWARD

For comparative purposes, the No Action Alternative (Alternative 1) is evaluated as a baseline condition. Three Action Alternatives, including the Proposed Action, are carried forward for detailed evaluation. All Action Alternatives meet fully, or in part, the purpose and need for the project and are the result of public and agency coordination. A summary can be found in Table 3-6.

All Action Alternatives would provide for aquatic organism passage upstream of the existing dam location. The Proposed Action and Alternative 3 would also restore connectivity and natural hydrological processes. Additionally, these two alternatives would eliminate liabilities associated with maintenance and operation of a Class I dam by its removal.

Table 3-6. Key Elements of the Action Alternatives

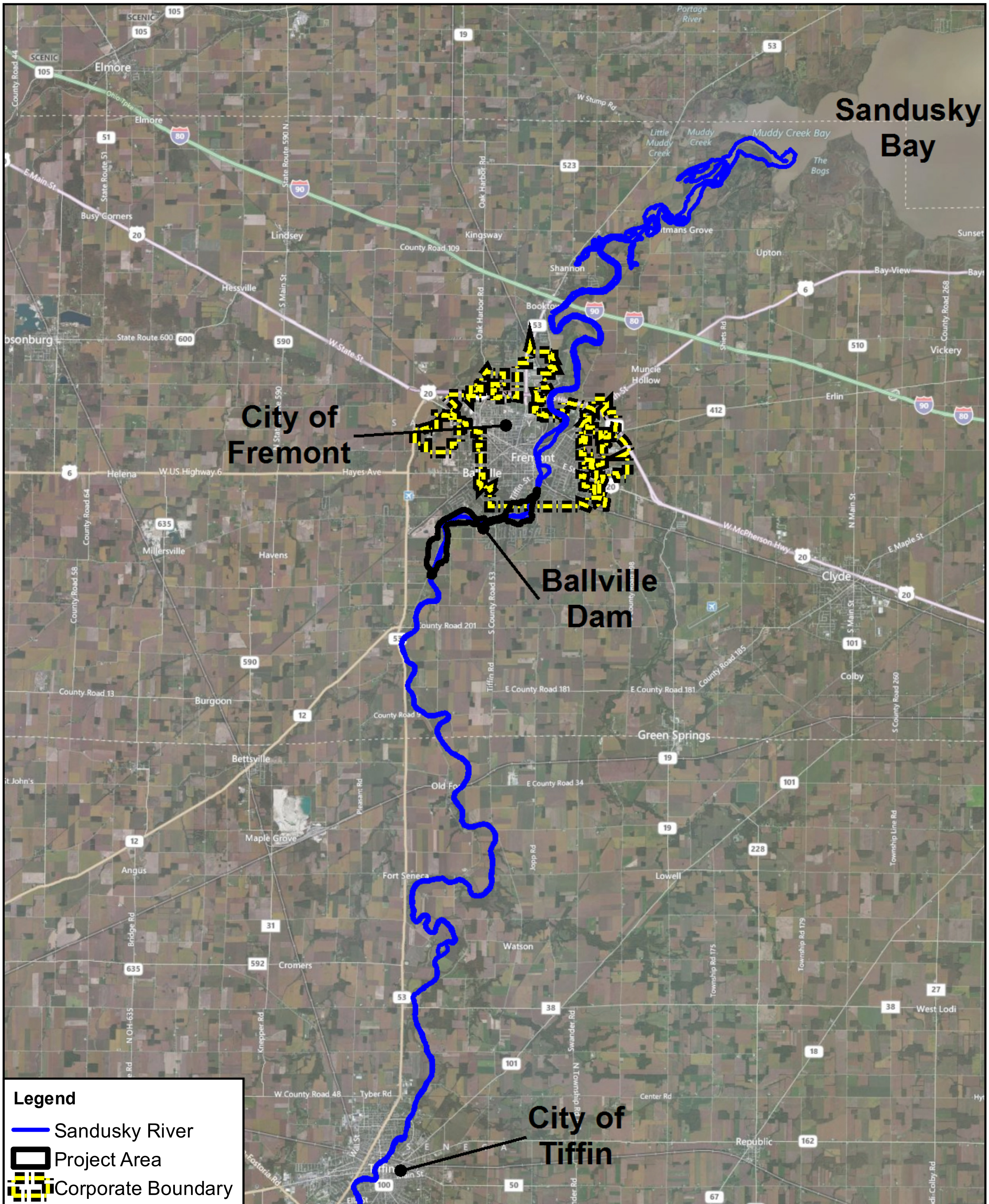
Feature	Proposed Action Incremental Dam Removal	Alternative 1 No Action	Action Alternative 2 Fish Passage Structure	Action Alternative 3 Dam Removal
Provide fish passage	Unobstructed fish passage	No	Use of fish elevator to provide upstream passage	Unobstructed fish passage
Restore river connectivity and natural hydrological processes	Yes	No	No	Yes
Minimize risk of Ice flooding to City of Fremont	Yes, by placement of ICS	Yes, by remaining in place	Yes, by remaining in place	Yes, by placement of ICS
Eliminate liabilities associated with maintaining the dam	Yes	No	No	Yes
Managing downstream movements of impoundment sediment	Allows for incremental sediment releases and interim sediment stabilization during multiple demolition events over several phases	Some sediment released downstream as result of sluice gate operation.	Some sediment released downstream as result of sluice gate operation.	Allows for sediment release during a single demolition event during one phase
Improved Designated Beneficial Uses (defined by OEPA) for the lower Sandusky River	Yes	No	No	Yes
Improving and increasing aquatic habitat availability in the lower Sandusky River downstream of the Ballville Dam site	Yes, improvement would be realized within a year of project completion as less sediment would be released to downstream habitats.	No	Not improved habitat downstream, but potential for increased availability for species which utilize the elevator system	Yes, improvement would be gradual over several years post project completion as sediment is moved downstream.

4.0 AFFECTED ENVIRONMENT

This chapter in the FEIS described the existing conditions near the Ballville Dam and its area of influence and vicinity. Resources were assessed using different spatial extents depending on the character of the resource and the extent of reasonably foreseeable project-related impacts. This approach is consistent with the Service's regulations implementing NEPA (USFWS 2003). The area of analysis for each resource was documented at the start of its discussion in this chapter.

Similarly to the FEIS, the Project Area, for the purposes of this chapter, is defined as the area that would be directly affected by the Proposed Action (Figure 1-1). This area would include the physical footprint of the Project facilities and would include workspaces for removal of the dam, access roads, staging areas and new construction areas (i.e. ICS). In some cases, potential effects to some resources could extend beyond the Project Area. Therefore, certain resources would be evaluated within a larger segment of the Sandusky River that extends upstream from the Project Area as far as Tiffin, Ohio (the next upstream dam) and downstream to include Sandusky Bay. This area is limited to the Sandusky River unless specifically stated otherwise. Figure 4-1 shows the Sandusky River from the city of Tiffin to Sandusky Bay.

The sediment analysis completed in September 2015 directly informs our understanding of the affected environment in the Ballville Dam Project area and occurred after completion of the FEIS. As such, below is a description of where this new information provides added detail and clarity to the FEIS regarding the Water Resources (FEIS Section 4.2) and Fish and Wildlife (FEIS Section 4.3). The remaining descriptions provided in Chapter 4 of the FEIS remain unchanged and are incorporated by reference.



Basemap: BING

Sandusky River From the City of Tiffin to Sandusky Bay

N
W
E
S

Ballville Dam Project

0 1 2 Miles

Figure 4-1

4.1 WATER RESOURCES

4.1.1 Scope of the Analysis

Water resources that could be affected by the Project extend beyond the Project Area. Therefore, this section presents a description of the water resources within the segment of the Sandusky River that extends from the Bacon Low Head Dam in Tiffin, Ohio to Sandusky Bay. In the FEIS, the water resources section included sections covering groundwater, surface water, wetlands, and water quality. However, as described in Section 2.1, the previously completed sediment testing for contaminants, the estimate of total quantity of sediment impounded by Ballville Dam, and the potential impacts of the Proposed Alternative on HABs in the Sandusky River and Lake Erie due to the proposed sediment release are three of the concerns identified as a focus of this Final SEIS. As such, the below description will focus on the new data gathered on sediment contaminant testing as well as further explanation of sediment quantity and HABs. This information will be used to help provide clarity and frame the alternatives analysis in Section 5.1.

4.1.2 Existing Conditions

4.1.2.1 Water Quality (Water Chemistry, Sediment Quantity, Sediment Quality)

4.1.2.1.1 Water Chemistry

Sediment and nutrient loads in the Sandusky River are high due in part to agricultural land uses in the Sandusky River basin. Ambient nutrient loads from the basin cause concern due to their potential to influence water quality in the Sandusky River and in Lake Erie. Excessive nutrients, especially phosphorus, can contribute to the formation of HABs.

These HABs in Lake Erie can be attributed to six to seven species of cyanobacteria but *Planktothrix spp.* and *Lyngbya wollei* are two types of particular concern because of their abundance in recent years. Explosive growth of HABs may degrade water quality, affect the aesthetic qualities of nearshore environments, limit recreational opportunities, and negatively alter the structural characteristics of aquatic habitats. Cyanobacteria may produce neurotoxins that affect the nervous system, hepatotoxins that affect liver function, and dermotoxins that may cause allergic skin reactions. One toxin called Microcystin is harmful to humans when ingested in drinking water or through direct contact. Microcystin has been observed in Lake Erie at concentrations of approximately 60 parts per billion (ppb), far above accepted standards for drinking water (1.0 ppb) and recreational contact (20 ppb; LEMNST 2011). In addition to toxicity issues, HABs may also form extensive foul smelling mats along the shoreline. *Lynbya wollei*, believed to be a recent invader of the Great Lakes, was observed to produce a mat of approximately 200 metric tons along only 100 meters of shoreline (Bridgeman and Penamon 2010). Algal blooms were observed in the Ballville Dam impoundment in 2010 and 2011. It is also pertinent to note that dense blooms of Planktothrix occur in Sandusky Bay seasonally

(Wynne and Stumpf 2015). Additionally, a bloom occurred in August 2014 in the Western Basin of Lake Erie that necessitated the closure of the water intake facility for the City of Toledo, OH.

The proliferation of HABs has been attributed to nutrient enrichment from anthropogenic sources. HABs are less able to compete with desirable forms of algae when phosphorus concentrations are below 5 ppb (LEMNST 2011). Further, their growth appears to be controlled by seasonal fluctuations in temperature with optimal growth occurring in the 25° to 30° Celsius (C) range and threshold temperatures for blooms greater than 15° C. Consequently, most HABs occur in late summer or early fall. Chaffin (2009) also observed that the spatial pattern of Microcystis blooms was spatially coincident with turbidity plumes from Maumee Bay.

Loading from the surrounding tributaries is the largest source of phosphorus for Lake Erie. The Maumee River and the Detroit River together account for 93 percent of the total phosphorus (TP) load to the western Lake Erie Basin (Limnotech 2010). However, the Sandusky River was not included in their analysis. Comparison of data presented in the Limnotech report and the data generated at the Heidelberg water quality monitoring station indicate that, while smaller, the Sandusky River is a substantial source of nutrients to Lake Erie (Table 4-1). Loadings from the Sandusky on a per square mile basis are one to three times greater than those from the Maumee River.

Table 4-1. Nutrient Loading Comparison (metric tons/year) for the Detroit, Maumee, and Sandusky Rivers1

Parameter	Detroit	Maumee	Sandusky
Mean Annual Flow (cfs)	172,000	7,000	1,075
Basin Area (mi^2)	*	6,330	1,251
Total Suspended Solids (TSS)	1,540,800	1,360,800	633,747
Total Phosphorus (TP)	2,968	1,175	688
Soluble Reactive Phosphorus (SRP)	885	391	174
Nitrate/Nitrite	57,454	25,802	13,153
Total Kjeldahl Nitrogen (TKN)	29,032	6,371	3,007

[1]Data for the Detroit River and Maumee River from 2004 - 2005 (Limnotech 2010) and data for Sandusky River 2004 - 2005 (Heidelberg Gage)
*not available

River discharge, suspended solids, and nutrient concentrations all exhibit some degree of seasonality with high concentrations coinciding with the wetter parts of the year (Figure 4-5). The Ballville Dam, because of its low trapping efficiency, has little or no effect on water flow or nutrient transport. The high load seasons tend to occur during the cooler parts of the year when HABs are less likely to occur. Nonetheless, the annual mean SRP concentration of 0.47 ppm is well above the 5 ppb number thought to favor more desirable forms of algae (LEMST 2011).

Additionally, when discussing HABs specifically in relation to Sandusky Bay, Davis et al., (2015) indicates that Sandusky Bay is a nitrogen-limited system. Specifically, Davis et al. (2015) indicates the nitrogen-responsiveness of the toxic cyanobacterial *Planktothrix* blooms in

Sandusky Bay, unlike the blooms encountered in Lake Erie's western basin, Sandusky Bay's algal blooms do not respond to additions of phosphorus.

4.1.2.1.2 Sediment Quantity

Suspended sediment data from the USGS gage, Sandusky River near Fremont located upstream of the dam at the highway bridge at Rice Road (approximately river mile 20), was used in the Ballville Dam Removal Feasibility Study (Stantec 2011). The analysis referenced suspended sediment concentrations recorded from 1979-2002 (period of record 1950-1956 and 1978-2002) in order to capture the most recent land use and watershed characteristics. Samples taken by the USGS at this location indicate that approximately 97 percent of the suspended sediment is composed of silt or clay sized particles (less than 0.0625mm), regardless of discharge. Data indicate that suspended sediment concentrations and loading were seasonally variable. Concentrations are highest during peak spring flow and agricultural activity months of April, May, and June. Monthly means for daily concentrations were higher than 50 mg/l in every month but September, October, and November. Peaks of the daily concentrations were greater than 500 mg/l in every month but October. The monthly means were substantially higher than monthly medians, an indication that a small number of very high concentrations (i.e., storm generated events) influence the mean. Daily sediment loads followed a similar seasonal pattern. Loading is highest during the wet season from February to May and the maximum observed load was 124,000 tons in a single day. After conversion from tons to cubic yards, the maximum single year suspended sediment load was 870,000 CY. These data indicate that the Sandusky River, its users, associated habitats and species have been subjected to exceedingly high sediment loads for a prolonged period of time.

The Ballville Dam impoundment has been accumulating and storing this sediment since its completion in 1913. Estimates of sediment depths within the impoundment range from 11 feet near the dam to over 20 feet near some outer margins. The type of stored sediment in the impoundment is representative of the watershed; overwhelmingly comprised of fine grained sediments (~90%), with coarse grained sediments being limited to the most upstream extents of the reservoir. The pattern of deposition and settling of coarse versus fine grained sediment was noted by Evans et al. (2002): the sediment texture is 5:10:85 ratio of gravel:sand:silt near the dam and 20:20:60 at the upstream end of the impoundment.

Recent sediment studies presented in Stantec (2011b) suggest that the dam is approaching, or has reached, an equilibrium state where very little new material is stored directly behind the dam despite the high volumes of sediment delivered from the watershed. Coarse particles are transported as bedload and collect at the upstream end of the impoundment as the water velocity slows entering the reservoir. Fine grained suspended sediments, such as silt and clay, are highly mobile, and continue to wash over the dam and move downstream.

Despite the sedimentation, a partially defined channel has remained within the substrate of the impoundment, as shown in photos and multiple bathymetric surveys. The island within the impoundment has formed within the last 30 years as sediment has continued to build a point bar on the inner portion of the river bend upstream of the dam. Its formation has promoted further deposition on the south shore downstream of the island. The island and other depositional areas at elevations above current 'normal' reservoir levels are now covered with mature vegetation and unlikely to be re-suspended even after the dam is removed.

The volume of potentially mobile sediments in the impoundment is a critical consideration for dam removal. To date there have been two estimates of sediment levels within the impoundment. First, in 2002, Evans et al. used a 1903 USGS pre-dam topography map and a 1993 bathymetric survey and estimated approximately 1.3 million cubic yards of sediment in the impoundment. Second, in 2011, Stantec completed a second estimate with a bathymetric survey that used newer, higher resolution instruments and estimated approximately 840,000 cubic yards of sediment in the impoundment (Stantec 2011).

The difference between the two estimates (approximately 460,000 cubic yards), may be attributed to a variety of factors, including the following:

- inaccuracies of the 1903 pre-dam topography map (10-foot contour intervals)
- differences between the 1993 and 2011 bathymetric surveys
    - water level differences between the two surveys that caused different amounts of land above normal pool water surface (e.g., the new island) to be included in the estimate
    - intrinsic differences in bathymetric survey methodologies
    - short-term fluctuations in sediment levels within the impoundment at the time of each survey (singular flood events capable of transporting one-day sediment loads equal to approximately one-sixth the total sediment stored behind the dam (see above USGS gage data)
- actual sediment addition/loss due to hydrology related to high flow events in the 18 year time period
- geomorphic changes in the 18-year time period between the surveys

Based on this information, we conclude that the 2011 calculation of 840,000 cubic yards is the best available estimate of quantity of sediment currently impounded by Ballville Dam. The 2011 survey is the most recent measurement of sediment volume and uses the highest resolution data and methodology. Further, we are confident that this is the best estimate of potentially mobile sediments, as all sediments at elevations above the water level in this survey are heavily vegetated, and thus would not be expected to be mobilized and washed downstream outside of some localized bank sloughing.

It is also helpful to view this quantity of sediment in relation to the sediment loads measured on an event and annual basis in the watershed. As previously discussed, as measured at the Fremont USGS gaging station, the largest measured sediment load was 867,000 cubic yards in one year (1984). Given that the dam has been in operation for more than 100 years, the estimated volume of accumulated sediment is relatively small.

4.1.2.1.3 Sediment quality

A wide variety of organic compounds and metals are continuously discharged into rivers from industrial, agricultural, and urban sources. Contaminants carried in runoff are adsorbed onto suspended particles and eventually settle to the sediments. Currently, there are no standard criteria or screening levels that can reliably predict when contaminants in sediment might exert toxic effects on the benthic community that lives in the sediments, or, indirectly affect human health. Sediment quality guidelines such as Threshold Effects Levels (TELs) and Probable Effect Levels (PELs) are used to predict when the chemical concentrations found in sediment may be acceptable. However, both TELs and PELs are not based on actual field assessments of toxicity or empirical data, but are instead based on short-term, laboratory run, toxicity tests, primarily conducted with sediment-dwelling organisms[5] using field-collected sediments that typically contain complex mixtures of contaminants. Therefore, values of TELs and PELs are predictive and not directly associated with any known or measured levels in-stream toxicity (Smith et al. 1996; USGS 2000).

To improve the ability of sediment quality guidelines to actually predict toxicity in field-collected sediments, consensus-based Probable Effect Concentrations (PECs) were developed by MacDonald et al. (2000). Consensus-based Probable Effect Concentrations are the average effect-level concentrations combined from several sources, resulting in the lower and upper effect values for contaminants of concern. Consensus-based PECs were developed using a database from across North America and have been used to reliably predict toxicity of sediments on a regional basis, including the Great Lakes basin (MacDonald et al. 2000). Ohio-specific Sediment Reference Values (SRVs) were developed to identify representative background sediment concentrations for lotic (flowing) water bodies. The SRVs used here were developed using a regional reference site approach that accounts for differences between Ohio’s five ecoregions. The SRVs presented in Table 4-2 are for the Huron-Erie Lake Plateau ecoregion, where Ballville dam is located (OEPA 2008a, USEPA 2000).

Sediment analysis in the Ballville Impoundment was conducted by Evans and Gottgens (2007) and included analysis for metals, pesticides, polychlorinated biphenyls (PCBs), and semi-volatile organic compounds, including polycyclic aromatic hydrocarbons (PAHs). No PAHs were detected. Table 4-2presents a comparison of the concentrations of metals and DDT breakdown products (e.g. 4,4-DDD and 4,4-DDE) detected in Ballville impoundment sediment compared to several sediment quality guidelines.

[5] Sediment-dwelling organisms are a suitable aquatic ecosystem surrogate because they represent an important linkage between primary producers and higher trophic levels and can serve as indicators for environmental stress. They access all aspects of the aquatic habitat with varying feeding strategies, reproductive modes, life history characteristics, and physiological tolerances to environmental conditions (USEPA 1992).

Table 4-2. Concentrations of metals and DDT breakdown products detected in Ballville Impoundment sediments (from Evans and Gottgens 2007)

Parameter	Minimum Detected Conc. (mg/kg)	Maximum Detected Conc. (mg/kg)	Average Sediment Conc. (mg/kg)	Threshold Effects Level[1] (mg/kg)	Probable Effects Level[2] (mg/kg)	Consensus Based Probable Effects Conc.[3] (mg/kg)	Huron-Erie Lake Plateau Sediment Reference Value[4] (mg/kg)
Aluminum	46,600	51,900	48,933.33	26,000	60,000		42,000
Arsenic	12.60	14.20	13.43	5.90	17	33*	11
Chromium	44	52	47	37.30	90	111*	51
Iron	31,000	34,000	32,766.67	19,000	25,000		44,000
Lead	35	35	35	35	91.30	128*	47[7]
Nickel	32	33	32.67	15.90[8]	42.80[8]	48.6*	36
Zinc	124	135	130.67	123	315	459*	190
4,4-DDD[5]	7.70	10.80	9.67	3.54	8.511	28	
4,4-DDE[6]	7.30	7.30	7.30	1.42	6.752	31.1*	

[1]Threshold Effect Levels (TELs) are sediment concentrations below which adverse effects are expected to occur only rarely (Smith et al. 1996).
[2]Probable Effect Levels (PELs) are sediment concentrations above which adverse effects in sediments are expected to frequently occur (Smith et al. 1996; USGS 2000).
[3]Probable Effect Concentrations (PECs) are consensus-based sediment concentrations above which harmful effects are likely to be observed; MacDonald et al. 2000a. An "*" designates a reliable PEC (>20 samples and >75% correct classification as toxic.
[4]Sediment Reference Values (SRVs) identify representative background sediment concentrations for lotic (flowing) water bodies in Ohio (OEPA 2008a).
[5]Value for sum of p,p'-DDD and o,p'-DDD.
[6]Value for sum of p,p'-DDE and o,p'-DDE.
[7]State-wide Sediment Reference Value.
[8]MacDonald et al. 2000.

None of the maximum detected concentrations of metals or DDT breakdown products exceeded the consensus-based PECs. Additionally, iron, lead, nickel and zinc were found below the appropriate SRV. The maximum detected concentration of chromium also approximates background reference conditions as represented by the SRV.

A consensus-based PEC is not available for aluminum, and the maximum detected concentration of aluminum exceeded the Ohio-specific SRVs. Aluminum silicates were found to be abundant in the fine-grained clay soils surrounding the Ballville impoundment.

However, a comparison of the metal concentrations in Ballville sediments, normalized for aluminum, shows that metal concentrations in the Ballville impoundment sediments are appreciably lower than the concentrations reported from Lake Erie sediments (Evans and Gottgens 2007).

4.1.2.1.4 Sediment Sampling (September 2015)

Sediment sampling within the Ballville Dam impoundment, and three locations below the dam in the Sandusky River, was completed in September 2015 and will assist in providing a clear understanding of existing contamination levels and any potential associated environmental concerns. The data obtained from the supplemental sampling will be used to inform decision making in regards to sediment safety and management relating to the disposition of the Ballville Dam. As such, the sampling focused on the following objectives to address the above goal:

1) Determine contaminant concentrations at various locations in the Ballville Dam impoundment sediment;
2) Compare Ballville Dam impoundment contaminant concentrations to sediment quality guidelines (SQGs) to determine the potential for those sediments to adversely impact aquatic organisms downstream if released;
3) Compare impoundment contaminant levels to downstream locations, using three additional grab samples around Brady's island, to better understand the levels in the area and assess potential ecological impacts if the dam were removed; and
4) Evaluate proper management of sediments that have been impounded behind the dam.

Sampling Design

Sampling was conducted in the impounded area behind the Ballville Dam on the Sandusky River and below the dam in the vicinity of Brady's Island (Figure 4-2 and Figure 4-3). Sediment cores from 10 locations within the Ballville Dam Impoundment (Figure 4-2, approximate locations) and three grab samples below the dam (Figure 4-3, approximate locations) were collected for chemical analyses. Sample sites in the impoundment were determined by assessing the likely areas that would mobilize during dam removal based on the bathymetric survey and assessment work completed by Stantec, Inc. The Brady's Island locations were identified as possible locations where elevation data indicated there may be some settling of sediments post dam removal. All sample locations were mapped with global position system data points and recorded.

It should also be noted that initially, several sediment core sample locations were to be split into two depth intervals (e.g., 0-10 feet and 10-20 feet), however refusal depths varied between a few feet and approximately 11 ft. Therefore, sediment cores were not split into sub-samples, but were homogenized as a single sample for each sample location and these homogenized samples were used for comparison to below-dam samples. Further, samples were extruded from the aluminum tube or Eckman sampler and notes taken on the sediment (e.g., color, texture, organic content). Representative samples from each horizon, if present, were homogenized using a stainless spoon and stainless steel bowl and placed into appropriate field containers. The raw data for this study can be found at:

http://www.fws.gov/midwest/fisheries/library/Ballville-SedimentData2015.pdf

Figure 4-2. Approximate sampling locations in the Ballville Dam Impoundment

Figure 4-3. Grab sample approximate locations near Brady's Island, downstream of Ballville Dam.

Sample Analysis

Sediment analyses included a range of the likely contaminants as well as physical analyses of grain size and organic carbon (Table 4-3).

Table 4-3. Categories of variables tested for in the sediment sampling completed in September 2015 and the reference(s) for the associated guidelines used to assess each respective variable.

Metals scan –including mercury	EPA 6020
Organochlorine Pesticides	EPA 8081A
Polychlorinated biphenyls (PCB Aroclors)	EPA 8082
Polyaromatic hydrocarbons (PAHs) scan	EPA 8270C
Total Phosphorus	CRL 435
Total Kjeldahl Nitrogen / Ammonia Nitrogen	CRL 468/CRL324

Data Analysis

For purposes of this evaluation, non-detects (below Method Detection Limit (MDL)) of a chemical in the sample were evaluated as the MDL value. The MDL value was used in place of a lower value (0 or 0.5 MDL) to ensure the worst case or highest possible concentrations were evaluated. An asterisk (*) next to a minimum value in the tables below denote the minimum value was below the MDL. Those concentrations quality control/quality assurance flagged with a "j" qualifier (i.e., the result is less than the Reporting Limit but greater than or equal to the MDL and the concentration is an approximate value) were retained as the approximate value in an effort to also ensure the evaluations considered the highest concentrations.

It should be noted that the sample matrix spike (MS), and matrix spike duplicates (MSD) for Sample H08 (Figure 4-2) for the majority of variables (all except for fluoranthene, pyrene, acenaphthylene, naphthalene) of polyaromatic hydrocarbons (PAHs) were flagged with F1 (MS and/or MSD recovery is outside acceptance limits) as a quality control/quality assurance issue. Samples flagged as such are typically excluded from evaluation, however for the purposes of this evaluation, the associated results for this sample was included in the evaluation for purposes of transparency and to ensure the highest concentrations were considered.

Both the arithmetic mean and geometric mean concentrations were calculated for the purpose of this evaluation. While the geometric mean is typically utilized for environmental contaminant evaluations because it provides an estimate of central tendency that is not unduly affected by extreme values, this evaluation utilizes the arithmetic mean concentrations. In all cases, the arithmetic mean concentration values were higher than the geometric mean values and were therefore reported in the tables below and utilized for comparison to sediment quality guidelines (SQGs).

The t-test statistic (1-tailed t-test, Excel) was used to determine whether the sediment concentrations in the impoundment differed from the sediment concentrations below the dam. The 1-tailed t-test was used instead of the 2-tailed t-test because it is more likely to reveal statistically significant differences as it was only used to assess the question of whether sediment samples in the impoundment were more contaminated than sediment samples downstream (i.e. evaluation is only concerned with contaminant concentrations significantly greater than those downstream). The t-test indicates the probability that the concentrations in the two sample locations are the same (the null hypothesis). If there is less than a 5% chance of obtaining the observed differences by chance, the null hypothesis is rejected and the conclusion is that a statistically significant difference between the two groups exists (i.e. mean concentrations in the two samples locations are not the same).

Results

A number of sediment quality guidelines (SQGs) for classifying sediment as toxic (contaminated) or non-toxic (relatively uncontaminated) have been developed by various federal, state, and provincial agencies to predict toxicity and impacts to benthic species at a study site. Approaches used to develop the guidelines each have advantages, limitations, levels of acceptance, different extent of field validation and differing degrees of environmental applicability.

As the Ballville Dam is located in Ohio, it is appropriate to utilize SQGs recommended by the state of Ohio for assessing the impact of sediment on aquatic life. Ohio EPA recommends the use of consensus-based sediment quality guidelines (CBSQGs) for freshwater ecosystems developed by MacDonald *et al*. (2000), ecological screening levels utilized by USEPA Region 5 (USEPA 2003), and for metal contaminants, the Ohio EPA sediment reference values (SRVs) (OEPA 2010). Ohio EPA SRVs for metals (OEPA 2008a) were developed using a regional reference site approach that accounts for differences between Ohio's five ecoregions. Ohio has recommended the use of these values for metals to identify representative background sediment concentrations for lotic (flowing) water bodies specific to Ohio.

In addition, a review of sediment quality evaluation guideline documents for several additional Great Lakes States (WDNR 2003, MDEQ 2013, MPCA 2007, NYDEC 2014) show that those states have also adopted the CBSQGs developed by MacDonald *et al*. (2000). These states indicated the guidelines provide a unifying synthesis of existing SQGs, reflect causal rather than correlative effects, and account for the effects of contaminant mixtures. The consensus-based SQGs substantially increase the reliability, predictive ability, and level of confidence in using and applying the guidelines.

Therefore, this evaluation will utilize the CBSQGs (MacDonald *et al*. 2000) and the SRVs to evaluate the data from the supplemental sampling of the Ballville Dam Impoundment and below the dam because they are the most reliable of the available SQGs due to the rigorous process in developing these values. Macdonald *et al*. (2000) has defined two concentration levels based on effects – a lower level consensus-based threshold effect concentrations (TECs) below which no or minimal effects on sediment-dwelling organisms are predicted and an upper level consensus-based probable effects concentration (PECs) above which adverse effects are highly probable or frequently observed (MacDonald *et al*. 2000). Compounds detected at concentrations below the TEC are considered to be "safe" while those above the PEC are to be considered "un-safe".

For the purposes of interpreting the potential impacts of chemical concentrations between the TEC and PEC values of the CBSQGs, the Wisconsin Department of Natural Resources (WDNR 2003) recommends the use of a midpoint effect concentration (MEC) calculated as the average of the TEC and PEC. Such a value provides the evaluator with a relative gauge of the potential impacts to the benthic species at that contaminant concentration. Such a value will be utilized in this evaluation for those compounds with a concentration between TEC and PEC values.

Tables 4-4, 4-5, 4-7, 4-9, 4-11, 4-12, and 4-14 below present contaminant concentration ranges and average concentrations compared to SQGs. Tables 4-6, 4-8, 4-10, 4-13, and 4-15 provide concentrations of contaminants in sediment from cores collected in the Ballville Impoundment compared to concentrations of contaminants in grab samples below the dam.

Metals

All metals in all samples were detected above respective MDL values (Table 4-4). Maximum concentrations detected in Ballville Impoundment sediment samples were compared to both the CBSQGs and the Huron-Erie Lake Plateau SRVs developed by Ohio EPA. For those compounds with SRVs available, only arsenic and nickel slightly exceeded the respective SRVs while the maximum detected concentrations for lead and mercury slightly exceeded the respective TECs. All remaining metal maximum concentrations were below the SRVs. None of the maximum concentrations of metals exceeded the PEC (adverse effects are highly probable or frequently observed) for those compounds with PEC values.

Table 4-4. Concentration range, arithmetic mean, consensus-based TECs and PECs and Huron-Erie Lake Plateau SRVs for metals. Bolded values indicate an SQG exceedance based on the maximum concentration of a metal.

Substance	Ballville Impoundment Range (n=10) mg/kg	Ballville Impoundment Arithmetic Mean mg/kg	Consensus-Based TEC mg/kg[1]	Consensus-Based PEC mg/kg[2]	Huron-Erie Lake Plateau SRV mg/kg[3]
Aluminum	2,300 – 13,000	7,700	NG	NG	42,000
Arsenic	5.5-**12**	9.0	**9.8**	33	**11**
Barium	14-100	59.9	NG	NG	210
Cadmium	0.09-0.74	0.40	0.99	4.98	0.96
Chromium	6.6-24	15.88	43	111	51
Copper	5.7-40	22.06	31.6	149	42
Iron	11,000-34,000	22,500	NG	NG	44,000

Table 4-4. Concentration range, arithmetic mean, consensus-based TECs and PECs and Huron-Erie Lake Plateau SRVs for metals. Bolded values indicate an SQG exceedance based on the maximum concentration of a metal.

Substance	Ballville Impoundment Range (n=10) mg/kg	Ballville Impoundment Arithmetic Mean mg/kg	Consensus-Based TEC mg/kg[1]	Consensus-Based PEC mg/kg[2]	Huron-Erie Lake Plateau SRV mg/kg[3]
Lead	5-**46**	22.09	**35.8**	128	NG
Magnesium	7,000-13,000	9,190	NG	NG	29,000
Manganese	200-580	370	NG	NG	1,000
Mercury	0.02-**0.22**	0.10	**0.18**	1.06	NG
Nickel	11-**37**	23.7	**22.7**	48.60	**36**
Potassium	340-1,500	933	NG	NG	12,000
Selenium	0.29-1.2	0.76	NG	NG	1.4
Zinc	30-150	88.1	121	459	190

NG – denotes no guidance available
[1&2] TECs & PECs - MacDonald et al. 2000.
[3]SRVs - OEPA 2008a.

To further evaluate the potential for Ballville Dam Impoundment sediments to adversely impact sediment-dwelling organisms for the four metals exceeding SRVs or TECs, the midpoint effect concentrations (MECs) have been calculated and are listed in Table 4-5. The maximum concentration detected for arsenic, lead, and mercury are below the MEC indicating a low level of concern regarding the toxicity of these chemicals to sediment-dwelling organisms. The maximum detected concentration for nickel was slightly above the MEC (Table 4-5).

The arithmetic mean concentrations for all metals were below the SRVs or TECs except for nickel which was slightly elevated above the TEC (23.7 mg/kg vs. 22.7mg/kg) but below the MEC and SRV.

Table 4-5. Concentration range, arithmetic mean, consensus-based TECs, MECs and PECs, and Huron-Erie Lake Plateau SRVs for metals.

Substance	Ballville Impoundment Range (n=10) mg/kg	Ballville Impoundment Arithmetic Mean mg/kg	Consensus-Based TEC mg/kg[1]	Consensus-Based Midpoint Effect MEC mg/kg[2]	Consensus-Based PEC mg/kg[2]	Huron-Erie Lake Plateau SRV mg/kg[3]
Arsenic	5.5-12	9.0	9.8	21.4	33	11
Lead	5-46	22.09	35.8	81.9	128	NG
Mercury	0.02-0.22	0.10	0.18	0.62	1.06	NG
Nickel	11-37	23.7	22.7	36	48.60	36

A comparison of the metal concentrations in Ballville impoundment sediments to those below the dam indicate metal concentrations in the Ballville impoundment sediments are not statistically different from those reported below the dam for approximately half the metals (Table 4-6). Concentrations of aluminum, arsenic, barium, iron, manganese, nickel, potassium, and selenium concentrations were statistically greater above the dam than concentrations below the dam. However as noted above the arithmetic mean concentrations of these metals were below the SRVs or TECs (except nickel).

Based on the above analysis, the potential for metals in the Ballville Impoundment sediment to adversely impact sediment-dwelling organisms if released is evaluated as low.

Table 4-6. Concentration ranges by compound in Ballville impoundment and below the dam, arithmetic mean ("average") in the impoundment and below the dam, and respective p-values (bolded when p<0.05).

Substance	Ballville Impoundment Range (n=10) mg/kg (dry wt.)	Below Dam Range (n=3) mg/kg	Ballville Impoundment Average mg/kg	Below Dam Average mg/kg	one-tail p-value
Aluminum	2,300 – 13,000	2,200- 4,600	7,700	3,300	**0.01**
Arsenic	5.5-12	4-6.7	9.02	5.00	**0.01**
Barium	14-100	24-40	59.9	29.67	**0.02**
Cadmium	0.09-0.74	0.16-0.44	0.40	0.34	0.31
Chromium	6.6-24	6.3-15	15.88	9.63	0.07
Copper	5.7-40	9.2-28	22.06	15.50	0.22
Iron	11,000-34,000	9,200-18,000	22,500	13,066	**0.02**
Lead	5-46	6.8-21	22.09	11.90	0.09
Magnesium	7,000-13,000	7,700-12,000	9,190	9,766	0.36
Manganese	200-580	160-270	370	213	**0.01**
Mercury	0.02-0.22	0.02-0.44	0.10	0.17	0.32
Nickel	11-37	9.7-17	23.7	12.57	**0.01**
Potassium	340-1,500	430-760	933	576	**0.04**
Selenium	0.29-1.2	0.4-0.65	0.76	0.48	**0.05**
Zinc	30-150	40-81	88.1	54.33	0.07

Organochlorine Pesticides

Only dichlorodiphenyldichloroethane (DDD) was detected above MDL in all samples. As stated previously, for the purposes of this evaluation, non-detects (below MDLs) are listed in Table 5 as the MDL values (equals minimum values) and are denoted by an asterisk (*).

Dieldrin was the only organochlorine pesticide with a maximum concentration greater than the consensus-based TEC. The maximum concentration of all other organochlorine pesticides with associated CBSQGs were detected below the consensus based TECs and all were well below consensus-based PECs (Table 4-7). While the maximum concentrations detected for dieldrin was above the consensus-based TEC, it was well below the consensus-based PEC and MEC (31.85) and the arithmetic mean value was below the consensus-based TEC.

Table 4-7. Concentration range, arithmetic mean, and consensus-based TECs and PECs for organochlorine pesticides. Bolded values indicate an SQG exceedance based on the maximum concentration of an organochlorine.

Substance	Ballville Impoundment Range (n=10) ug/kg (dry wt.)	Ballville Impoundment Arithmetic Mean ug/kg (dry wt.)	Consensus-Based TEC ug/kg[1]	Consensus-Based PEC ug/kg[2]
Aldrin	*0.05-0.23	0.09	NG	NG
alpha-Chlordane	*0.07-0.52	0.26	3.2	18
DDD	0.11-2.4	1.49	4.88	28.0
DDE	*0.05-1.1	0.62	3.16	31.3
DDT	*0.04-0.53	0.28	4.16	62.9
delta-BHC	*0.04-0.18	0.06	NG	NG
Dieldrin	*0.06-**2.8**	0.90	**1.90**	61.8
Endosulfan I	*0.05-0.11	0.07	NG	NG
Endosulfan II	*0.05-0.19	0.09	NG	NG
Endosulfan Sulfate	*0.03-0.24	0.06	NG	NG
Endrin	*0.05-0.39	0.11	2.22	207
Endrin aldehyde	*0.05-0.07	0.06	NG	NG
Endrin ketone	*0.04-0.11	0.06	NG	NG
gamma-Chlordane	*0.05-0.61	0.20	3.24	17.6
Heptachlor	*0.06-0.08	0.07	NG	NG
Heptachlor Epoxide	*0.05-0.20	0.09	2.47	16.0
Hexachlorocyclohexane, Alpha-	*0.05-0.20	0.07	NG	NG
Hexachlorocyclohexane, Beta-	*0.07-0.14	0.09	NG	NG
Hexachlorocyclohexane, Gamma- (Lindane)	*0.05-0.68	0.12	2.37	4.99
Methoxychlor	*0.06-0.18	0.08	NG	NG
Toxaphene	*1.8-3.0	2.16	NG	NG

* indicates minimum value below MDL
[1&2]MacDonald, et al (2000).

Comparison of organochlorine pesticide concentrations in the Ballville Impoundment sediments and below the dam resulted in no statistical difference (1-tailed t-test, $p>0.05$) between the two locations for all pesticides except for endosulfan II, gamma-chlordane, and heptachlor epoxide (Table 4-8). However, as noted above the maximum concentrations of these organochlorine pesticides were below TECs. Therefore, the potential for organochlorine pesticides in the Ballville Impoundment sediment to adversely impact sediment-dwelling organisms if released is evaluated as low.

Table 4-8. Concentration ranges by compound in Ballville impoundment and below the dam, arithmetic mean in the impoundment and below the dam, and respective p-values (bolded when p<0.05).

Substance	Ballville Impoundment Range (n=10) ug/kg	Below Dam Range (n=3) ug/kg	Ballville Impoundment Arithmetic Mean ug/kg	Below Dam Average ug/kg	one-tail p-value
Aldrin	0.05-0.23	0.05-0.12	0.09	0.08	0.30
alpha-Chlordane	0.07-0.52	0.29-0.94	0.26	0.72	0.08
DDD	0.11-2.4	0.75-1.8	1.49	1.17	0.24
DDE	0.05-1.1	0.34-0.75	0.62	0.56	0.37
DDT	0.04-0.53	0.30-0.83	0.28	0.59	0.09
delta-BHC	0.04-0.18	0.04-0.06	0.06	0.05	0.16
Dieldrin	0.06-2.8	0.66-1.3	0.90	0.93	0.48
Endosulfan I	0.05-0.11	0.07-0.11	0.07	0.08	0.19
Endosulfan II	0.05-0.19	0.05-0.06	0.09	0.05	**0.04**
Endosulfan Sulfate	0.03-0.24	0.03-0.04	0.06	0.03	0.09
Endrin	0.05-0.39	0.05-0.07	0.11	0.06	0.10
Endrin aldehyde	0.05-0.07	0.05-0.07	0.06	0.06	0.48
Endrin ketone	0.04-0.11	0.04-0.06	0.06	0.05	0.26
gamma-Chlordane	0.05-0.61	0.06-0.07	0.20	0.06	**0.03**
Heptachlor	0.06-0.08	0.06-0.08	0.07	0.07	0.48
Heptachlor Epoxide	0.05-0.20	0.05-0.07	0.09	0.06	**0.04**
Hexachlorocyclohexane, Alpha-	0.05-0.20	0.05-0.06	0.07	0.05	0.15
Hexachlorocyclohexane, Beta-	0.07-0.14	0.07-0.09	0.09	0.08	0.19
Hexachlorocyclohexane, Gamma- (Lindane)	0.05-0.68	0.05-0.06	0.12	0.05	0.15
Methoxychlor	0-06.18	0.06-0.08	0.08	0.07	0.23
Toxaphene	1.8-3.0	1.9-2.4	2.16	2.13	0.45

Polychlorinated Biphenyls (PCBs)

Only Aroclors 1254 and 1260 were detected above MDL in all Ballville Impoundment samples. Detection of Aroclors 1016, 1221, 1232, 1242 and 1248 were all below the MDL for all impoundments samples (Table 4-9). For the purposes of this evaluation the MDL values have been indicated in Table 4-9 to be considered in the total PCB calculation, which is the sum of the maximum values of all Aroclors. Consensus-based TEC and PEC values are provided for total PCBs.

The total PCB concentration in Ballville Impoundment sediments do not exceed the consensus-based TEC for PCBs.

Table 4-9. Concentration range, arithmetic mean, and consensus-based TECs and PECs for total PCBs.

Substance	Ballville Impoundment Range (n=10) ug/kg (dry wt.)	Ballville Impoundment Arithmetic Mean ug/kg (dry wt.)	Consensus-Based TEC ug/kg[1]	Consensus-Based PEC ug/kg[2]
Aroclor 1016	*0.24-0.32	0.28	-	-
Aroclor 1221	*0.38-0.50	0.45	-	-
Aroclor 1232	*0.13-0.17	0.16	-	-
Aroclor 1242	*0.20-0.25	0.23	-	-
Aroclor 1248	*0.12-0.16	0.14	-	-
Aroclor 1254	0.25-2.6	1.67	-	-
Aroclor 1260	0.23-2.3	1.43	-	-
Total PCBs	6.3 (sum of maximum values)	4.4	59.8	676

* indicates minimum value below MDL
[1&2]MacDonald, et al (2000).

Comparison of PCB concentrations in the Ballville Impoundment to concentrations in samples taken below the dam indicate no statistical difference (1-tailed t-test, p>0.05) in PCB concentrations above and below the dam (Table 4-10). The potential for PCBs in the Ballville impoundment sediment to adversely impact sediment-dwelling organisms if released is evaluated as low.

Table 4-10. Concentration ranges by compound in Ballville impoundment and below the dam, arithmetic mean in the impoundment and below the dam, and respective p-values.

Substance	Ballville Impoundment Range (n=10) ug/kg	Below Dam Range (n=3) ug/kg	Ballville Impoundment Average ug/kg	Below Dam Average ug/kg	one-tail p-value
Aroclor 1016	0.24-0.32	0.26-0.33	0.28	0.29	0.39
Aroclor 1221	0.38-0.50	0.41-0.52	0.45	0.46	0.40
Aroclor 1232	0.13-0.17	0.14-0.18	0.16	0.16	0.45
Aroclor 1242	0.20-0.25	0.21-0.26	0.23	0.23	0.40
Aroclor 1248	0.12-0.16	0.13-0.17	0.14	0.15	0.43
Aroclor 1254	0.25-2.6	0.74-2.1	1.67	1.25	0.23
Aroclor 1260	0.23-2.3	0.69-1.6	1.43	1.05	0.17

Polyaromatic Hydrocarbons (PAHs)

The MS and MSD for Sample H08 for the majority (all except for fluoranthene, pyrene, acenaphthylene, naphthalene) of PAHs were flagged with F1 (MS and/or MSD recovery is outside acceptance limits) as a quality control/quality assurance issue. Samples flagged as such are typically excluded from evaluation, however the H08 samples values were included in the table below to ensure the greatest potential concentrations are evaluated. The maximum detected concentrations (all from sample H08) of most analyzed PAHs exceeded consensus-based TEC values with the exception of naphthalene. Maximum detected concentrations for benzo(a)anthracene, dibenz(a,h)anthracene, fluoranthene, phenanthrene and pyrene exceeded consensus-based PEC values. The arithmetic mean for anthracene, benzo(a)anthracene, phenathrene and pyrene exceeded the consensus-based TEC values, however none of the arithmetic means exceeded the consensus-based PEC values.

PAH toxicity is typically evaluated based on the total PAH concentration, which is calculated from the sum of maximum concentrations of individual compounds and exceeds the consensus-based TEC value for total PAHs but is below the consensus-based PEC value (Table 4-11).

Table 4-11. Concentration range, arithmetic mean, consensus-based TECs and PECs for PAHs. Bolded values indicate an SQG exceedance based on the maximum concentration of a PAH.

Substance	Ballville Impoundment Range (n=10) ug/kg (dry wt.)	Ballville Impoundment Arithmetic Mean ug/kg (dry wt.)	Consensus-Based TEC ug/kg[1]	Consensus-Based PEC ug/kg[2]
Acenaphthene	3.4-170	26	NG	NG
Acenaphthylene	3.3-36	13	NG	NG
Anthracene	7.7-**450**	64	**57.2**	845
Benzo(a)anthracene	7.8-**1100**	154	**108**	**1050**
Benzo(a)pyrene	*2.1-**990**	145	**150**	1050
Benzo(b)fluoranthene	5.9-1100	169	NG	NG
Benzo(g,h,i)perylene	*2.1-800	134	NG	NG
Benzo(k)fluoranthene	*4.3-480	70	NG	NG
Chrysene	18-**1000**	161	**166**	1290
Dibenz(a,h)anthracene	*2.3-**150**	18	**33**	**135**
Fluoranthene	53-**2800**	400	**423**	**2230**
Fluorene	7.2-**210**	37	**77.4**	536
Indeno(1,2,3-c,d)pyrene	2.2-580	94	NG	NG
Naphthalene	*2.4-64	13	176	561
Phenanthrene	31-**1700**	240	**204**	**1,170**
Pyrene	48-**1800**	282	**195**	**1520**
Total PAHs	13,430 (maximum value)	1,982	**1610**	22,800

* - indicates minimum value below MDL
[1&2]MacDonald et al. 2000

To further evaluate the potential for Ballville dam impoundment sediments to adversely impact sediment-dwelling organisms for PAHs exceeding consensus-based TECs, the midpoint effect concentrations (MECs) have been calculated (Table 4-12). Except for anthracene and fluorine the maximum concentration values exceeded the consensus-based MEC values. Arithmetic mean concentrations of the PAHs did not exceed any of the MECs.

Comparison of PAH concentrations in the Ballville Impoundment to concentrations in the samples taken below the dam indicate no statistical difference in PAH concentrations above and below the dam (Table 4-13).

Table 4-12. Concentration range, arithmetic mean, consensus-based TECs, MECs, and PECs for PAHs.

Substance	Ballville Impoundment Range (n=10) ug/kg (dry wt.)	Ballville Impoundment Arithmetic Mean ug/kg (dry wt.)	Consensus-Based TEC ug/kg[1]	Consensus-Based MEC ug/kg	Consensus-Based PEC ug/kg[2]
Anthracene	7.7-450	64	57.2	480	845
Benzo(a)anthracene	7.8-1100	154	108	633	1050
Benzo(a)pyrene	*2.1-990	145	150	675	1050
Chrysene	18-1000	161	166	811	1290
Dibenz(a,h)anthracene	*2.3-150	18	33	101	135
Fluoranthene	53-2800	400	423	1538	2230
Fluorene	7.2-210	37	77.4	345	536
Phenanthrene	31-1700	240	204	789	1,170
Pyrene	48-1800	282	195	955	1520
Total PAHs	13,430 (sum of maximum values)	1501	1610	13,010	22,800

Table 4-13. Concentration ranges by compound in Ballville impoundment and below the dam, arithmetic mean in the impoundment and below the dam, and respective p-values.

Substance	Ballville Impoundment Range (n=10) ug/kg	Below Dam Range (n=3) ug/kg	Ballville Impoundment Average ug/kg	Below Dam Average ug/kg	one-tail p-value
Acenaphthene	3.4-170	5.6-33	26.11	18.53	0.34
Acenaphthylene	3.3-36	5.4-14	12.83	11.13	0.35
Anthracene	7.7-450	18-41	63.77	29.67	0.23
Benzo(a)anthracene	7.8-1100	54-68	154.48	62.67	0.20
Benzo(a)pyrene	*2.1-990	43-59	145.41	53.33	0.18
Benzo(b)fluoranthene	5.9-1100	55-96	169.09	78.33	0.20
Benzo(g,h,i)perylene	*2.1-800	34-65	134.01	54.00	0.16
Benzo(k)fluoranthene	*4.3-480	21-25	70.13	23.00	0.17
Chrysene	18-1000	60-94	161.40	82.00	0.21
Dibenz(a,h)anthracene	*2.3-150	2.8-8.7	18.46	4.90	0.19
Fluoranthene	53-2800	120-220	400.30	176.67	0.21
Fluorene	7.2-210	7-29	36.72	18.33	0.19
Indeno(1,2,3-c,d)pyrene	2.2-580	31-49	93.92	41.00	0.18

Table 4-13. Concentration ranges by compound in Ballville impoundment and below the dam, arithmetic mean in the impoundment and below the dam, and respective p-values.

Substance	Ballville Impoundment Range (n=10) ug/kg	Below Dam Range (n=3) ug/kg	Ballville Impoundment Average ug/kg	Below Dam Average ug/kg	one-tail p-value
Naphthalene	*2.4-64	3.7-15	12.77	8.57	0.27
Phenanthrene	31-1700	47-130	240.20	85.33	0.19
Pyrene	48-1800	84-180	281.80	134.67	0.21

* - indicates minimum value below MDL

Nitrogen and Phosphorus

Most states do not list sediment quality guidelines for nitrogen and phosphorus. The most applicable guidelines found were from the Ontario Ministry of Environment and Energy (1993), which are listed in the table below. The guidelines provide levels of ecotoxicological effects and are based on the chronic, long term effects of contaminants on benthic organisms. Below the lowest effect level (LEL) indicates a level of sediment contamination that can be tolerated by the majority of benthic organisms, while above the severe effect level (SEL) indicates the level at which pronounced disturbance of the sediment-dwelling community can be expected. Concentrations between the LEL and SEL indicate a potential for some affect for some benthic organisms. Based on these guidance values the maximum concentration of total nitrogen and phosphorus in sediments in the Ballville Impoundment were above the LEL but well below the SEL (Table 4-14).

Table 4-14. Concentration range and arithmetic mean for ammonia (as nitrogen), total nitrogen, and total phosphorus in sediment and SQG.

Substance	Ballville Impoundment Range mg/kg (dry wt.)	Ballville Impoundment Arithmetic Mean mg/kg (dry wt.)	Lowest Effect Level mg/kg [1]	Severe Effect Level mg/kg[1]
Ammonia as Nitrogen	16-540	251	NG	NG
Nitrogen, Kjeldahl	310-2700	1562	550	4800
Phosphorus	310-1300	757	600	2000

[1]Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. 1993. Persaud, D., R. Jaagumagi, and A. Hayton. Ministry of Environment and Energy. Pg. 1-39. August 1993.

Comparison of ammonia (as nitrogen), total nitrogen, and total phosphorus concentrations in the Ballville Impoundment sediment samples to concentrations in samples taken below the dam indicate no statistical difference (1-tailed t-test, $p>0.05$) in total nitrogen and total phosphorus above and below the dam (Table 4-15). Ammonia in the sediment above the dam was statistically significantly ($p<0.05$) higher than in sediment below the dam.

Table 4-15. Concentration ranges by compound in Ballville impoundment and below the dam, arithmetic mean in the impoundment and below the dam, and respective p-values (bolded when less than 0.05).

Substance	Ballville Impoundment Range (n=10) mg/kg	Below Dam Range (n=3) mg/kg	Ballville Impoundment Mean mg/kg	Below Dam Mean mg/kg	one-tail p-value
Ammonia as Nitrogen	16-540	6.4 - 46	251	21	**0.00**
Nitrogen Kjeldahl	310-2700	630-1500	1562	927	0.08
Phosphorus	310-1300	350-800	757	527	0.12

Summary and Conclusions

The conclusions of this evaluation are based on comparing contaminant concentrations in samples collected from the Ballville Dam Impoundment to consensus-based TECs (concentrations below which no or minimal effects on sediment-dwelling organisms are predicted), consensus-based MECs (a midpoint concentration calculated from TECs and PECs), and consensus-based PECs (concentration above which adverse effects are highly probable or frequently observed) along with comparison of contaminant concentrations in the impoundment with contaminant concentrations below the dam.

Summarizing the above tables and evaluations:

- Metals
    - Maximum concentrations of arsenic and nickel slightly exceeded the respective SRVs
    - Maximum concentrations for lead and mercury slightly exceeded the respective TECs
    - Maximum concentration for all metals below MECs except nickel (slightly exceeded)
    - Arithmetic mean concentrations for all metals were below the SRVs or TECs except for nickel (23.7 mg/kg vs. 22.7mg/kg)
    - Arithmetic mean for nickel was below the MEC
    - PECs were not exceeded for any metal
    - Concentrations of aluminum, arsenic, barium, iron, manganese, nickel, potassium, and selenium concentrations were statistically greater above compared to below the dam
    - Metals evaluated as low concern for adversely impacting sediment-dwelling organisms

- Organochlorine pesticides
    - Maximum concentration of Dieldrin exceeded TEC, but well below MEC
    - Maximum concentration of all other organochlorine pesticides below TECs
    - Maximum concentrations of all organochlorine pesticides below PECs
    - Arithmetic mean value for all organochlorine pesticides below TECs
    - Concentrations of organochlorine pesticides in the impoundments are not statistically different from concentrations below the dam.

    - Organochlorine pesticides evaluated as very low concern for adversely impacting sediment-dwelling organisms

- PCBs
    - Only Aroclors 1254 and 1260 were detected above MDL
    - Total PCBs (sum of maximum concentrations) do not exceed TEC value
    - Concentrations of PCBs in the impoundment sediment is not statistically different from concentrations below the dam
    - PCBs evaluated as very low concern for adversely impacting sediment-dwelling organisms

- PAHs
    - Sample H08 flagged with F1 (MS and/or MSD recovery is outside acceptance limits) quality control/quality assurance qualifier, but retained in evaluation
    - Maximum concentrations of PAHs (except naphthalene) exceeded TECs
    - Maximum PAH concentrations, except for anthracene and fluorine, exceeded the consensus-based MEC values
    - Maximum concentrations for benzo(a)anthracene, dibenz(a,h)anthracene, fluoranthene, phenanthrene and pyrene exceeded PEC values
    - Total PAH (sum of maximum concentrations) was below the total PAH PEC value
    - Arithmetic mean for anthracene, benzo(a)anthracene, phenathrene and pyrene exceeded the consensus-based TEC values, however none of the PAH arithmetic means exceeded the MEC, or PEC values
    - Concentrations of PAHs in the impoundment are not statistically different from concentrations below the dam.
    - PAHs evaluated as some but minimal concern for adversely impacting sediment-dwelling organisms.

- Nitrogen and Phosphorus
    - Maximum concentration of total nitrogen and phosphorus in sediments in the Ballville Impoundment were above the LEL but well below the SEL.
    - Concentrations of total nitrogen and total phosphorus in the Ballville Impoundment sediment samples were not statistically different from concentrations below the dam.
    - Ammonia in the sediment above the dam was significantly higher than in sediment below the dam.

Maximum concentrations for metals, organochlorine pesticides and PCBs generally do not exceed the consensus-based TEC values and none of the maximum concentrations for compounds from these contaminant classes exceed the consensus-based PEC values. Arithmetic means for compounds in these classes do not exceed the TECs.

Nitrogen and phosphorus exceed the LEL, but do not exceed the SEL values. The levels of these nutrients indicate a minimal potential for some affect to occur in some benthic organisms.

The only class of contaminants which may be potentially of concern for adversely impacting sediment-dwelling organisms is PAHs. While one sample exhibited elevated levels of PAHs, the two samples (H09, H10) in the same vicinity did not exhibit elevated PAH concentrations. While the maximum concentrations for benzo(a)anthracene, dibenz(a,h)anthracene, fluoranthene, phenanthrene and pyrene exceeded PEC, the arithmetic mean for all the PAH compounds were below PEC values. The total of maximum PAH concentrations were below the PEC. Using maximum value for comparison purposes is conservative especially given that the bulk of the material moving downstream once the Ballville Dam is breached will be more likely closer to the average concentration than the maximum.

In addition, the sediment samples collected in the impoundment above the Ballville Dam were not statistically different than those below the dam with the exception of aluminum, arsenic, barium, iron, manganese, and nickel. However the maximum concentrations for these metals fell below either the PECs or the Huron-Erie Lake Plateau Sediment Reference Value (SRV) and the average concentrations of all the metals were below the TECs or SRVs.

4.2 FISH AND WILDLIFE (AQUATIC POPULATIONS)

4.2.1 Scope of Analysis

In the FEIS, the Fish and Wildlife section included sections covering terrestrial wildlife and aquatic wildlife, including fish, mussels, macroinvertebrates, invasive species, established invaders, and potential invaders. As described in Section 2.1, the potential impacts of the Proposed Alternative on downstream habitats due to sediment release is one of the concerns identified as a focus of this Final SEIS. As such, below is a description of the affected environment specific to the aquatic populations that occur within the Project Area and within the larger section of the Sandusky River and its riparian borders within the Project Area. Additionally, it considers aquatic species that could potentially occur from the Bacon Low Head Dam in Tiffin, Ohio downstream to Sandusky Bay. This information was incorporated directly from the FEIS and has not been altered. It is included in this Final SEIS to help provide clarity and frame the alternatives analysis in Section 5.2.

4.2.2 Existing Conditions

4.2.2.1 Aquatic Wildlife

4.2.2.1.1 Fish

In July 2011, OEPA reported results of fish sampled at river miles 15.4, 16.8, 18.5 (located within the Ballville Dam impoundment), 19.5, 21.3, and 23.4 (7). In total, 45 species were collected. Species richness was highest at River Mile 16.8 (n = 30) and lowest at River Mile 18.5 (n = 15) (Table 4-7). Three species classified as “intolerant” (OEPA 1989) to water quality degradation were collected in the surveys: Greater Redhorse, River Redhorse, and Black Redhorse (*Moxostoma erythrurum*). The Greater Redhorse (Ohio threatened) was collected both above and below the Ballville impoundment. Common Carp (*Cyprinus carpio*), Goldfish (*Carassius auratus*), Ghost Shiner (*Notropis buchanani*), and White Perch (*Morone americana*), all non-native species, were collected during the surveys. Carp were especially abundant and comprised a major proportion of the biomass at all sites surveyed. The Freshwater Drum (*Aplodinotus grunniens*), an important host species for freshwater mussels, was collected downstream but not upstream of the dam.

Table 4-16. Fish Species by River Mile, Ballville Dam is located at river mile 18 (OEPA 2011a).

Common Name (*Species Name*)	**River Mile**						**Total**
	15.4	**16.8**	**18.5**	**19.5**	**21.3**	**23.4**	
Black Redhorse (*Moxostoma duquesnei*)					18	128	**146**
Golden Redhorse (*Moxostoma erythrurum*)	105	94	30	52	151	46	**478**
Greater Redhorse (*Moxostoma valenciennesi*)	3	1		1	2	1	**8**
N. Hog Sucker (*Hypentelium nigricans*)				1	14	16	**31**
Quillback (*Carpiodes cyprinus*)	11	16	5	2	2		**36**
River Redhorse (*Moxostoma carinatum*)		3	1		2	6	**12**
Shorthead Redhorse (*Moxostoma macrolepidotum*)		4					**4**
Silver Redhorse (*Moxostoma anisurum*)	4	9		3	4	14	**34**
Smallmouth Buffalo (*Ictiobus bubalus*)	10	30					**40**
Spotted Sucker (*Minytrema melanops*)			25	26			**51**
White Sucker (*Catostomus commersonii*)				4			**4**
Bigmouth Buffalo (*Ictiobus cyprinellus*)		2					**2**
Black Crappie (*Pomoxis nigromaculatus*)		1					**1**
Bluegill (*Lepomis macrochirus*)	7	1	1	4			**13**
Green Sunfish (*Lepomis cyanellus*)	2		5	6			**13**
Green X Bluegill (*L. cyanellus X L. macrochirus*)	3	3	8	9			**23**
Green X Pumpkinseed (*L.cyanellus X L. gibbosus*)				1			**1**
Largemouth Bass (*Micropterus salmoides*)			5	6			**11**
Orangespotted Sunfish (*Lepomis humilis*)	10	4	43	35	5		**97**
Pumpkinseed (*Lepomis gibbosus*)				1			**1**
Rock Bass (*Ambloplites rupestris*)				1	13	29	**43**
Smallmouth Bass (*Micropterus dolomieu*)	5	7		1	12	25	**50**
White Crappie (*Pomoxis annularis*)		4	2	1			**7**
Gizzard Shad (*Dorosoma cepedianum*)	56	15					**71**
Bluntnose Minnow (*Pimephales notatus*)		9	3	9	7	2	**30**
Carp (*Cyprinus carpio*)	5	81	15	25	12	18	**156**
Emerald Shiner (*Notropis atherinoides)*	19						**19**
Ghost Shiner (*Notropis buchanani*)							
Golden Shiner (*Notemigonus crysoleucas*)			1	3			**4**
Goldfish (*Carassius auratus*)	16						**16**
Sand Shiner (*Notropis stramineus*)	10	8		1	14	5	**38**
Spotfin Shiner (*Cyprinella spiloptera*)	3	53	31	62	22	34	**205**
Spottail Shiner (*Notropis hudsonius*)	1						**1**

Table 4-16. Fish Species by River Mile, Ballville Dam is located at river mile 18 (OEPA 2011a).

Common Name (*Species Name*)	River Mile						Total
	15.4	16.8	18.5	19.5	21.3	23.4	
Suckermouth Minnow (*Phenacobius mirabilis)*						1	**1**
Northern Pike (*Esox lucius*)		1					**1**
Brown Bullhead (*Ameiurus nebulosus*)		2	7				**9**
Channel Catfish (*Ictalurus punctatus*)	1	36			10	21	**68**
Flathead Catfish (*Pylodictis olivaris*)		1					**1**
Yellow Bullhead (*Ameiurus natalis*)				2		1	**3**
Longnose Gar (*Lepisosteus osseus*)	5	13					**18**
Logperch (*Percina caprodes*)	1	4			13	10	**28**
Yellow Perch (*Perca flavescens*)	1	1					**2**
Freshwater Drum (*Aplodinotus grunniens*)	18	30					**48**
White Bass (*Morone chrysops*)	13	3					**16**
White Perch (*Morone americana*)	1	1					**2**
Total	**310**	**446**	**182**	**256**	**301**	**357**	**1852**

4.2.2.1.2 Mussels

Several limited mussels surveys within the project area have occurred recently. A survey within the impounded area near the new raw water reservoir intake was conducted in 2010 (EnviroScience 2010a). No live or dead mussels were found within the survey area, however, one live giant floater (*Pyganodon grandis*) was found approximately 100 feet (30.5 meters) downstream. Stantec (2011b) surveyed areas from immediately below the dam to the Hayes Avenue Bridge on September 1 and 2, 2011 (FEIS Appendix A10. Eighty-one live animals comprising twelve species and one additional species as a weathered valve were observed (Table 4-17). No federally listed taxa were found. However, one live three-horn wartyback (*Obliquaria reflexa*; Ohio Threatened) and 23 deertoe (*Truncilla truncata*; Ohio SOC) were observed. The surveyed area was characterized as having exceedingly poor habitat (i.e. cobble and boulders, exposed bedrock) for freshwater mussels (Stantec 2011b).

Table 4-17. Species Count and Condition for 2011 Mussel Surveys, Sandusky River Below Ballville Dam, Sandusky County, Ohio

Species	Common Name	Live	Fresh Dead	Weathered	Subfossil
Actinonaias ligamentina	Mucket	1			
Amblema plicata	Threeridge	1			1
Lampsilis cardium	Pocketbook	1			
Lasmigona complanata	White Heelsplitter	19		5	
Lasmigona costata	Fluted Shell	2		2	
Leptodea fragilis	Fragile Papershell	2			
Obliquaria reflexa	Three-horn Wartyback	1			
Potamilus alatus	Pink Papershell	19		4	

Table 4-17. Species Count and Condition for 2011 Mussel Surveys, Sandusky River Below Ballville Dam, Sandusky County, Ohio

Species	Common Name	Live	Fresh Dead	Weathered	Subfossil
Pyganodon grandis	Giant Floater	3		2	1
Quadrula pustulosa	Pimpleback	1			
Quadrula quadrula	Mapleleaf	8	3	2	1
Strophitus undulatus	Creeper			1	
Truncilla truncata	Deertoe	23		7	1
Total		**81**	**3**	**23**	**4**

4.2.2.1.3 Macroinvertebrates

OEPA (2011a) conducted macroinvertebrate sampling in the Lower Sandusky River watershed in 2009. Eight sampling locations were selected for monitoring from downstream from Wolf Creek (RM 22.73) to the head of Sandusky Bay (RM 0.0). Upstream from Fremont (RM 21.30), macroinvertebrate indices scored in the exceptional range (ICI=58) (OEPA 2011a). The OEPA Report (2011a) indicates, "The Ballville Dam impounds the river within the city of Fremont. Sampling of the dam pool predictably yielded depressed biological sampling results due to siltation and habitat alteration… the macroinvertebrate community was in poor condition at RM 18.05. Downstream from the Ballville Dam the next two sites, RMs 17.70 and 15.40, were in full attainment." ICI scores for these reaches are presented in Table 4-4.

4.2.2.1.4 Invasive Species

Nearly 200 non-native species have become established in the Great Lakes ecosystem and, on average, a newly established invader is discovered in the basin every eight months (Great Lakes Restoration Commission 2005). Successfully established invasive species such as the Sea Lamprey and the Quagga mussel have profoundly altered the structural and functional elements of the ecosystems they colonized. As a consequence, globally important habitats have been fundamentally altered, sensitive or rare species are threatened with extinction, and social and commercial interests have been irreparably damaged.

An undetermined number of invasive species currently occupy habitats within the project vicinity. Species such as the Common Carp and the Asiatic Clam (*Corbicula fluminea*) are established invaders and would not be easily eradicated. Other known species currently at risk to invade, such as the Silver Carp (*Hypophthalmichthys molitrix*) and Bighead Carp (*H. nobilis*), may potentially colonize the Great Lakes and connected waters. It is difficult to predict what species may be the next to colonize, although tools such as invasive species risk assessments can help us to better anticipate and plan for future invasions.

4.2.2.1.5 Established Invaders

A cursory review of available data revealed that the non-native species in Table 4-9 are relatively well established in the project vicinity.

Table 4-18. Non-native Species and Approximate Great Lakes Invasion Date

Species	Invasion Date
Common Carp (*Cyprinus Carpio*)	1879
White Perch (*Morone americana*)	1950s
Reed Canarygrass (*Phalaris arundinacea*)	unknown
Honeysuckle (Lonicera spp.)	1800s
Purple Loosestrife (*Lythrum salicaria*)	1869
Zebra Mussel (*Dreissena polymorpha*) / Quagga Mussel (*Dreissena rostriformis*)	1988-1989
Asiatic Clam (*Corbicula fluminea*)	1980
Ghost Shiner (*Notropis Buchanani*)	1979

Source: Mills et al. 1994 and Holeck et al. 2004

4.2.2.1.6 Potential Invaders

Additional species have invaded the Great Lakes and associated water bodies at an astonishing rate over the past century (Strayer and Dudgeon 2010). It is difficult to predict, with any certainty, which of these species would be the next to colonize successfully and which would fail to materialize in the vicinity of Ballville Dam. Discussion in the following sections is limited to two of the known threats to Great Lakes aquatic ecosystems that may reasonably occur in the project vicinity.

Sea Lamprey. One of the most damaging of the Great Lakes invaders, Sea Lamprey, has yet to become established in the Sandusky River (Coldwater Task Group 2011). The Sea Lamprey first entered the Great Lakes in the 1830s and later accessed Lake Erie through the Welland Canal system in 1921 (Trautman 1981). In the adult lifestage, Sea Lampreys are parasitic and attach to, and feed off, of large bodied fish including Lake Trout (*Salvelinus namaycush*), Steelhead (*Oncorhynchus mykiss*), and Burbot (*Lota lota*) among others. The Lake Trout population crash in Lakes Huron, Superior, and Michigan coincided with the establishment of Sea Lamprey (Smith 1973). Several methods for controlling the spread of these animals are currently in place. They include: Lampricide (chemical treatment of streams to kill larval Sea Lampreys); barriers; and trapping.

The Sea Lamprey Control Program (SLC), through the Service and Great Lakes Fishery Commission, work to reduce populations using the above actions. SLC also maintains records relating to spawning tributaries in the Great Lakes to help identify suitable Sea Lamprey habitat and provide review and comment relating to range expansion when barrier removals are proposed around the Great Lakes Basin. This helps them to lend their expertise and ensure barrier removals do not inadvertently allow for the expansion of Sea Lamprey populations. According to their review of this project as it relates to Sea Lamprey concerns:

"… We fished an adult Sea Lamprey trap at the dam in 2001 and did not capture any. While there is Lamprey spawning and larval habitat present up and downstream of the dam, we have never found any larval Sea Lampreys or native Lampreys up or downstream of the dam. The lower portion of the river is a large estuary with low flow which may deter entrance into the river. Overall, there was not enough evidence to suggest that Sea Lampreys would become a problem in the river …"

Following up on their previous work, SLC sampled near the mouth of the Sandusky River on June 6-7, 2012 using granular bayluscide plots. No Sea Lamprey were captured during this sampling event, further supporting their opinion related to potential suitability of Sea Lamprey habitat in Sandusky River.

Asian Carp. Four species of Asian Carps (Bighead, Silver, Grass (*Ctenopharyngodon idella)*, and Black Carp *(Mylopharyngodon piceus)*) are present in the Mississippi and Ohio River Basin, and are moving closer to the Great Lakes watershed (Abdusamadov 1987; Jennings 1988). Historically, between the years 1995 and 2000, three live Bighead Carp were captured in western Lake Erie, although none have been captured since. More recently, July 31 – August 4, 2012, water samples from Sandusky Bay and River (near Fremont, Ohio) and Maumee Bay indicated positive results for Silver Carp Environmental DNA (eDNA) (ODNR 2012a; ODNR 2012b). Samples of eDNA were collected in June 2013 in both the Maumee River and the Sandusky River, and although all samples taken in the Sandusky River were negative, one sample from the Maumee River was positive for Silver Carp DNA (ODNR 2013c).

Environmental DNA is one tool used to sample the environment and can help managers determine the presence of species specific DNA in the water. However, there are many possible eDNA vectors, in addition to live individuals, which could explain its presence including bird feces, boats or equipment used in multiple water bodies, contaminated sewage outputs, etc. (United States 2013, USACE 2013). With this in mind, the detection of Asian Carp eDNA in a water body suggests only that DNA is present, but it does not conclusively indicate the presence of live individuals. For example, linkages between the Wabash and Maumee River basins (i.e., Eagle Marsh and Grand Lake St. Mary's) may offer potential routes of entry to the Great Lakes as do illicit introductions or unintentional bait transfers, however, there may also be a number of other important vectors to consider.

There is widespread concern that Asian Carps, if able to colonize the Great Lakes, could potentially disrupt food webs and threaten sport and commercial fisheries (GLRC 2005). To investigate the associated risk relating invasive Asian Carp species to Ballville Dam, a risk analysis process was completed. The risk analysis consisted of an in-depth evaluation by expert panelists intended to evaluate two key elements relating Asian Carps to the Ballville Dam:

- Risk of establishment of Asian Carp species (Silver Carp, and/or Bighead Carp, and/or Grass Carp, and/or Black Carp), in the Sandusky River and Lake Erie, via various pathways, and

- Potential impacts, of an established population[s] of Asian Carps, on the Sandusky River and Lake Erie.

To complete this analysis, a panel of eleven experts was formed. Individuals were selected based on their expertise and knowledge related to the technical questions that formed the basis of the review, and in a manner to ensure broad representation of the various entities engaged in Asian Carp prevention in Lake Erie and the Sandusky River. The risk analysis was completed based on anticipated impact on fish passage of each alternative, No Action, Fish Passage Structure, and Dam Removal with Ice Control Structure or Incremental Dam Removal with Ice Control Structure. The results of this analysis are detailed in Chapter 5 - Environmental Consequences of the FEIS, Sections 5.3.2, 5.3.3, 5.3.4, and 5.4.5, respectively. Also, the complete Risk Analysis Summary Report can be found as FEIS Appendix E.

5.0 ENVIRONMENTAL CONSEQUENCES

This section is intended to ensure a complete evaluation of the project alternatives and their potential impacts specifically in relation to the new information noted in section 4.1.2.3.1. This chapter describes and compares the environmental impacts of each of the four alternatives identified in Chapter 3 carried forward for detailed analysis. Each section of this chapter details the impacts as they are understood for each of the alternatives including the Proposed Action. The impacts identified in this chapter are based on technical reports and analyses that were included in the FEIS as well as associated appendices, with the addition of the recent reviews, analyses, and communications with subject matter experts. Given the purpose of this Final SEIS (See Section 2.1) to integrate the newly obtained information, this chapter focuses on impacts related to potential sediment movement on downstream fish and aquatic habitats, sediment quantity and quality, and potential impacts related to HABs.

After review and consideration, the new information gathered does not change the resulting analysis of the No Action Alternative or Alternative 2 – Fish Passage Structure from that indicated in the FEIS. This is primarily due to the fact this Final SEIS is focused primarily on sediment and its potential impacts in a dam removal scenario and that in both the No Action Alternative and Alternative 2 – Fish Passage Structure, the dam is rehabilitated with limited change in sediment disposition. As such, the analysis provided for the No Action Alternative and Alternative 2- Fish Passage Structure in this chapter are incorporated directly from the FEIS. However, based on the new information and focus of the Final SEIS, changes based on the new information have been made to the analyses for the Proposed Action and Alternative 3 – Dam Removal with Ice Control Structure.

The following terms define the primary analysis for this Final SEIS.

- Construction refers to all activities carried out during any of the four alternatives. Construction does not end until all activities have been completed and no work remains outside of operation and maintenance.
- Post-Construction refers to the time after construction has been completed. This includes operation and maintenance.
- Mitigation Measures are those actions that are carried out in order to lessen the impact or effect of a particular action.

5.1 WATER RESOURCES (WATER CHEMISTRY, SEDIMENT QUALITY, SEDIMENT QUANTITY)

5.1.1 Impact Criteria

This analysis evaluates how the four alternatives would potentially affect existing water resources, specifically water quality as defined in the Final SEIS Section 4.1.1. Project effects to water resources would be considered significant should any of the following result:

- Degraded aquatic resources that result in losses in biodiversity or degraded water quality or quantity; or
- Dramatic changes to other resources, such as flora or fauna, either beneficial or damaging related to affected water resources conditions.

At the Federal level, water resource impacts are regulated by the Federal Water Pollution Control Act (Clean Water Act) of 1972, Executive Order 11988: Floodplain Management (1977), Executive Order 11990: Protection of Wetlands, Wild and Scenic Rivers Act of 1968, and the Safe Drinking Water Act of 1974. In addition, state and local agencies have developed legislation that regulates water quality, discharges, and floodplain development within the state. This includes its designation as a State of Ohio Scenic River. Impacts to water resources are discussed in the following sections as either direct or indirect. Direct impacts refer to construction activities that require the direct placement or excavation of fill materials. Indirect impacts or secondary impacts refer to hydrologic alteration that may consequentially occur as a result of dam removal.

5.1.2 Proposed Action

5.1.2.1 Construction Effects

The magnitude and duration of water quality impacts resulting directly from dam removal depend on many factors including:

- the volume and composition of sediments stored upstream of the dam;
- river discharge at the time of the breach and in the months that follow;
- suspended solids and/or turbidity concentrations at the time of the breach;
- channel slope;
- basin area;
- time that has passed since demolition; and
- the distance from the dam location.

The Proposed Action construction is segmented into phases; each with sub-phases designed to complete the project in the least environmentally damaging way. Phase 1 would remove a small section of the dam resulting in a “notch” in the south spillway of Ballville Dam that is 20 feet wide and 10 feet tall. Notching the dam would produce a base level change and would lower the hydraulic control on pool elevation from 625 to 615 feet at low flows. The upstream channel within the former pool would be expected to respond to this new elevation control with a series of adjustments such as upstream knickpoint migration, incision, and subsequent below water channel widening (Schumm and Parker 1973, Womack and Schumm 1977). This cycle of knickpoint migration, incision, and widening would likely occur repeatedly until a new stable bed elevation is achieved along the length of the impoundment. However, it is possible that the next phase of dam demolition would begin before the process of adjustment is complete. Fine-grained sediments would be mobilized and exported to downstream reaches during and immediately after construction associated with the notch. The magnitude of sediment export would be limited by the relatively small hydraulic capacity of the notch (Riggsbee et al. 2007) and may not differ substantially from the existing condition. Additional sediment would be exported by storm-generated stream flows in the months following the notch. The remainder of Ballville Dam would be demolished during Phase 2. Channel adjustment and sediment export would follow similar processes described above. However, channel incision would be constrained by currently submerged bedrock outcrops rather than the dam. A pulse of stored sediment would be exported to downstream reaches during the demolition process. Subsequent pulses would be mobilized during storm generated high flow events. The impoundment would no longer constrain the physical forces necessary to mobilize and transport coarse-grained substrates.

It is not possible to calculate the exact volume of sediment discharge using currently available scientific methods. However, studies from other dam removal projects can be used to place sediment loads in context (Major et al. 2012). The Marmot Dam, on the Sandy River in Oregon, was demolished in a single rapid breach. Fifteen percent of the total stored sediment volume was exported downstream in the first 60 hours after breaching. Another 35 percent was exported during the winter wet season following the initial breaching of the dam. Storms in the winter months of the second wet season resulted in an additional six percent of the total sediment yield from the former impoundment, which suggests that the channel approached a dynamic equilibrium. Thus 44 percent of the total stored sediment volume remained in place and was not transported to downstream reaches in the case of the Sandy River.

Based on the analysis described in Section 4.1.2.1.2, and on other studies of dam removal, if it is assumed that approximately half the sediment stored would be mobilized and exported during dam removal, roughly 470,400 CY (consistent with Major et al. 2012), then that sediment would deposit on less than ¼ of the surface area available downstream. In that case, the depth of deposition would be approximately 3/8 of an inch (1 centimeter) (following notching of the dam in Phase 1 and removal in Phase 2). Even if the entire volume stored by the impoundment was mobilized, 840,000 CY, the depth of deposition would be only 2/3 of inch (1.7 centimeters). It is also important to compare the loading from removal of the dam in comparison to loading from the Sandusky River watershed that occurs regularly. It is currently estimated that 840,000 CY are stored in the impoundment. Between 1979 and 2002, the Sandusky River watershed delivered 8,828,000 CY yards of sediment to the USGS Gauge 0419800 located at Tindall Bridge. Maximum loading events totaled approximately 867,000 CY delivered by the watershed in a single year and 143,000 CY in a single day (Stantec 2011). The mean annual load is approximately 368,000 CY, nearly half the estimated volume of material currently stored in the impoundment (840,000 CY). Thus, the Sandusky River ecosystem is capable of, and routinely transports, high sediment loads similar to what is expected to occur from dam removal. Impacts related to these routine sediment flow conditions are a component of the Sandusky River ecosystem, which continues to show resiliency to high sediment loading from the surrounding watershed.

The notch approach is intended to diminish the initial delivery of sediment to downstream reaches by limiting the depth of incision to elevation 615 feet rather than the much lower bedrock elevation of 596 feet. This alternative also constrains storm driven export because the impoundment would maintain backwater conditions during higher flows. The dimensions of the notch are only large enough to convey approximately 2,000 cubic feet/second (cfs), which is large enough for approximately 90 percent of the summer and autumn discharge values. Larger flows would continue to produce backwater conditions behind the dam. Under the backwater conditions both slope and velocity would be reduced thereby limiting shear stress available to initiate sediment mobilization. Riggsbee et al. (2007) demonstrated that backwater conditions caused by a notch limited both sediment concentrations and overall loading during storm events in comparison to measurements collected after complete removal of the dam. The notch would concentrate flows on one side of the dam and would allow demolition to occur under drier conditions. The notch would also draw down the pool level enough for seeding to occur on approximately 20 acres of formerly submerged areas in an attempt to limit erosion and mobilization of fine grained sediment.

It is important to note that in addition to notching and dam removal as described in the proposed action, small short term increases in instream sediment transport could also be a result of construction of access roads, construction of the ICS and rehabilitation of the seawall. Some bank sloughing may occur after the impoundment is dewatered and a new river channel forms.

Concentrations of suspended solids are not expected to increase appreciably over concentrations observed routinely in the river during notching and dam removal (Stantec 2011). When modeling the impacts of release of the stored sediment, it was predicted that in a wet year, high flow concentrations remain in the range of 50 to 500 mg/L (Stantec 2011). The mean annual daily total suspended solids (TSS) concentration in the period between 1979 and 2002 was 89 mg/L. Observed high flow concentrations in the same period ranged between 109 and 590 mg/L. Impacts to the lower Sandusky River and Lake Erie would be minimized through release during the different phases of the Proposed Action. Minimizing the sediment transport and seeding exposed stored sediment would aid in water quality recovery.

In addition to the potential impact of releasing sediment downstream, it is important to consider the quality of those sediments and any contaminants or chemicals they may introduce as they travel to downstream environments during construction. As such, Section 4.1.2.1.3 describes two independent rounds of sediment testing completed on the sediment impounded by Ballville Dam. After analyzing the results, the concentrations of contaminants do not appear to be at levels that would cause adverse environmental effects if the Ballville dam was removed. The maximum detected concentrations of organochlorine pesticides and PCBs did not exceed any SQGs. Individual metal concentrations fell below either the PECs or the Huron-Erie Lake Plateau Sediment Reference Value (SRV) and the average concentrations of all the metals were below the TELs, TECs or SRVs. The maximum detected concentrations of most analyzed SOCs fell below the PECs with the exception of acenaphthene, benzo(a)anthracene, dibenz(a,h)anthracene, fluoranthene, and phenanthrene. The total PAH concentration is below the PEC for total PAHs and the average concentrations of all SOCs fall below their respective PECs.

In addition, the sediment samples collected in the impoundment above the Ballville dam were not statistically different than those below the dam with the exception of aluminum, arsenic, barium, iron, manganese, and nickel, but the concentrations for these metals fell below either the PECs or the Huron-Erie Lake Plateau Sediment Reference Value (SRV) and the average concentrations of all the metals were below the TELs, TECs or SRVs. There was also a statistical difference for ammonia between those samples above and below Ballville Dam, however no phosphorus and nitrogen were not statistically different.

The conclusion from the evaluation of the results from the supplemental sediment sampling is that the removal of the Ballville dam would not cause adverse environmental effects due to contaminants contained in the sediment. This is because the levels of contaminants are either below levels that would be expected to result in adverse effects, or because the levels of contaminants in the sediments in the impoundment are not significantly different than the levels of contaminants in the sediments below the dam.

Western Lake Erie aquatic ecosystems have had recurring HABs in recent years, and understanding construction phase impacts from the Proposed Action on the production of HABs is pertinent to the consideration of this alternative. To ensure an accurate assessment of this important potential impact, experts from Ohio State University, University of Toledo, and Bowling Green State University were independently asked to review and consider this concern during the development of the Draft SEIS. Their responses indicated that removing the Ballville Dam and the release of impounded sediments will not impact cyanobacterial blooms in Sandusky Bay or Lake Erie proper. Specifically, in a letter dated December 11, 2015 received from Dr. Chaffin at The Ohio State University's Franz Theodore Stone Laboratory regarding Ballville Dam impounded sediments and their potential impact on HABs Dr. Chaffin noted:

> "1. Microcystis blooms in the western basin are most prevalent cyanobacterial blooms in Lake Erie and have drawn the most media attention in recent years. Microcystis produces the cyanotoxin microcystin and was responsible for the Toledo water crisis in August 2014. Summer Microcystis blooms begin in the nutrient rich waters of Maumee Bay and spread eastward by water currents (Chaffin et al., 2011; 2014). The biomass and spatial extent of the blooms are controlled by Maumee River spring to early summer discharge, as higher discharges load larger amounts of phosphorus and nitrogen into the lake (Stumpf et al., 2012). Microcystis blooms will only extend beyond the western basin and into the central basin in years with extremely high discharge (due to heavy rains). Therefore, because Microcystis blooms began in Maumee Bay and spatial extent is controlled by Maumee River discharge, any discharge from the Sandusky River will not affect the Microcystis bloom.
>
> 2. Each year more than 1 million cubic yards of sediments are dredged from the Toledo shipping channel and disposed directly in the open waters western basin. A recent study found that open lake disposal of dredge sediments had no impact on the cyanobacterial

blooms in the western basin (Ecology and Environment Inc. and LimnoTech, 2014). That study found that phosphorus (both particulate and dissolved) released from sediment disposal was minimal in comparison to Maumee River loading and background basin-wide lake bottom suspension due to winds. There is an estimated 840,000 to 1,300,000 cubic yards of impounded sediments behind the Ballville Dam (Evans et al., 2002; Stantec, 2011), which is similar to the amount of dredged sediments disposed in the western basin. If Ballville dam removal releases all impounded sediments into Lake Erie (it is not likely that all sediments are mobile) and if those sediments have similar characterizes as Maumee sediments (which is a reasonable assumption because the watershed use between the Maumee River and Sandusky River are similar and highly agricultural), then we can expect a similar and non-impact on cyanobacterial blooms in Lake Erie.

3. In order to put the sediment release in perspective in terms of phosphorus, we need to calculate the total mass of phosphorus in the 840,000 cubic yards of impounded sediments and compare that mass to the annual phosphorus load to Lake Erie from the Sandusky River. Drawing upon the Maumee River dredged sediments, which had a wet weight density of 1.395 g/cm3 and a wet-to-dry ratio of 0.51 (Ecology and Environment Inc. and LimnoTech, 2014), the 840,000 cubic yards of sediments would have a dry mass of 456,912 metric tons. The average phosphorus content of sediments above the Ballville dam was 757 mg P/kg (Elkington's email, Dec. 10 2015 [Table 4-15]). This would give a total of 346 metric tons of phosphorus in the 840,000 cubic yards of sediment. 346 metric tons of phosphorus would be released and loaded to the system if 100% of the sediments were mobile. However, it is estimated that only 500,000 to 700,000 cubic yards are mobile, which results in 205 to 288 metric tons of phosphorus. Total phosphorus loads from the Sandusky River are highly variable and fluctuate with rain fall. Since the mid 1970's total phosphorus load from the Sandusky River has ranged between 150 to 1000 metric tons per year (Baker et al., 2014). The mass of phosphorus that could potentially be released by removing the Ballville dam is in the lower range of the normal phosphorus load from the Sandusky River and three times less than the average phosphorus load of 688 metric tons per year reported in the EIS. Furthermore, dense blooms of Planktothrix plague Sandusky Bay every summer (Wynne and Stumpf, 2015) regardless of the nutrient load from the Sandusky River. Thus, the phosphorus released by removing the Ballville dam will not impact Sandusky Bay because the total mass of phosphorus is relatively low compared to historical loads and the density of Planktothrix blooms is not related to nutrient loads.

4. Phosphorus load from the Sandusky River is a small proportion (~10%) of the total phosphorus load to Lake Erie (Scavia et al., 2014). A marginal increase of phosphorus from the Sandusky River due to Ballville dam removal will have no effect on Lake Erie ecology. Furthermore, most of the outflow from Sandusky Bay into Lake Erie hugs the shoreline. Thus, sediments and phosphorus from the Sandusky system remain in the shallow near-shore zones and do not contribute to central basin hypoxia and will not contribute any meaningful phosphorus through internal loading during hypoxia events.

5. Recent research has shown that Sandusky Bay is a nitrogen-limited system (Davis et al., 2015), which means that nitrogen, and not phosphorus, regulates phytoplankton biomass. Thus, additional phosphorus to Sandusky Bay will not stimulate cyanobacterial blooms. River sediments have very low nitrogen to phosphorus ratios and in the nitrogen-limiting range. Thus, Planktothrix will not receive additional growth stimulus because the impounded sediments are too low in nitrogen."

Additionally, experts from the University of Toledo and Bowling Green State University both made specific notes regarding internal loading of phosphorus. Dr. McKay of Bowling Green University stated that "Most likely the redox environment of impounded sediment is conducive to release of soluble phosphorus (via dissimilatory Fe reduction) and phosphorus introduced by "internal loading" is already entering the river behind the dam. Also relevant to these arguments is the fact that Sandusky Bay, the body of water receiving this flow, is typically a nitrogen-depleted system... For the most part, Sandusky Bay's algal blooms do not respond to additions of phosphorus (unlike the blooms encountered in Lake Erie's western basin). Thus, even is removal of the dam were to result in a large flux of soluble phosphorus to Sandusky Bay (which we don't believe it will), we would not expect a bloom event to occur."

To further investigate this topic and respond to comments received on the Draft SEIS, we reconnected with Dr. Chaffin and reached out to additional professors at Defiance College and Heidelberg University to ensure as clear an understanding as possible regarding nutrient loading in relation to Ballville Dam impounded sediments and the health of the Lake Erie system. Those comments and their responses can be found in Appendix B1.

In summary, we independently reached out to experts from five different universities in the State of Ohio working on nutrient loading, HAB's, and Lake Erie eutrophication issues and asked them to objectively review the available information regarding Ballville Dam and the potential impacts of the Proposed Alternative. Although each academic researcher took a slightly different approach to considering the variables and used slightly different estimates for their calculations, they all reached the same conclusion. The removal of Ballville Dam under the Proposed Alternative is not expected to have significant negative impacts on HAB's or Lake Erie eutrophication. Alternatively, in each independent response, the researchers mentioned a variety of positive benefits to the ecosystem related to completing the Proposed Alternative.

5.1.2.2 Post Construction Effects

Demolition of Ballville Dam and the subsequent release of sediments would likely result in localized accumulation (aggradation) of sediment downstream from the dam (Stantec 2011). This would be followed by a series of hydrologic processes, creating a channel within the former impoundment and moving mobile sediments further downstream.

The channel that forms in place of the impoundment is expected to reach a relatively stable position within one to two years of the complete removal. The data presented in Major et al.

(2012) demonstrated that approximately 50 percent of the stored sediment volume was exported in the first year after removal, but only six percent in the second year despite much higher flows. The small magnitude of export in the second year is an indication of a channel approaching stability.

Prior studies of dam removal have documented the formation of a “sediment wedge” from the released sediment (FEIS Appendix A11). Sediment transport modeling conducted by Stantec (2011b) suggests that depths of sediment aggradation would vary spatially. Quantitative modeling evaluated the transport of material currently in the impoundment into the downstream reach of the river over two scenarios, a ‘dry’ year and a ‘wet’ year, to represent a range of potential conditions. Streamflow and sediment data from the 2001 and 2008 Water Years (sediment values extrapolated for 2008) recorded at the USGS gage, Sandusky River near Fremont, were used to represent the dry (2001) and wet (2008) years. Annual mean daily streamflow during 2001 is in the 13th percentile for the period of record (Water Years 1924-2014) and the annual peak streamflow was in the 7th percentile. In contrast the 2008 Water Year was one of the wettest on record, with the second highest (98th percentile) annual mean daily streamflow on record between 1924 and 2014, as well as the 7th highest (93rd percentile) annual peak streamflow over the same period. Using these data as a baseline, sediment loadings were increased by factors of 2 and 10-times the original daily sediment values to evaluate model sensitivity to increased loadings. Results produced sediment concentration, load and deposition on a daily time-step for each modeled reach. For example, Figure 5-1 depicts sediment concentration, had the sediment load transported during the February 7, 2008 flood event been magnified up to 10 times. Note that the “10x” sediment loading cases result in sediment loadings at the upstream boundary of the modeled reach of the river well in excess of the amount of estimated sediment in the dam impoundment (Stantec 2011).

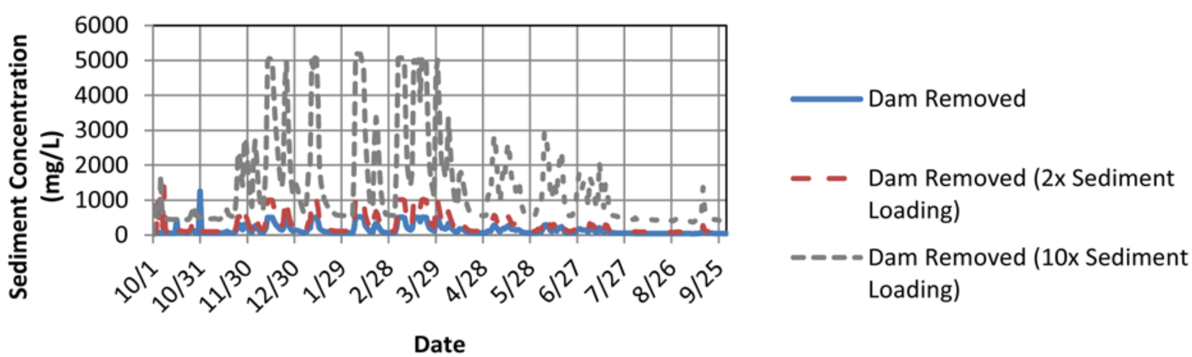


Figure 5-1. 2008 Water Year Sediment Concentrations at Station 82000 (Stantec 2011). This station is located near the golf course in the vicinity of identified walleye spawning habitat at the upstream end of the levee system in Fremont.

The results of the 1-dimensional sediment transport analysis indicate that the maximum height of aggraded sediment from an immediate release of the entire sediment wedge (840,000 CY) would be approximately 2.5 feet (0.8 meters) at HEC-RAS cross-section Station 63000 (Figure 5-2); however, typical depths of sediment would be less than 1 foot (0.3 meters). It is important to note that this analysis did not include evaluation of localized aggradation, which could result in greater reductions in depth. As can be seen in Figure 5-2, the maximum sediment aggradation depths were calculated during summer low flows while the stream power generated by the river, even during small flood events (i.e. the 5- or 10-year flow), is sufficient to transport enough volume of sediment to bring the channel back to pre-dam breach conditions. These results predict an alternating pattern of sediment deposition during low flow and scour during high flow, indicating that streambed sediment depths in the river are lowest during periods that suspended sediment concentrations are highest (i.e., flood events). It should be noted that the proposed action was designed to result in the release of smaller volumes of sediment over a longer time frame (not one event) by phasing the removal and stabilizing the exposed sediment by seeding and vegetative plantings. This is expected to minimize the size of the sediment wedge and the magnitude of suspended sediment associated with any given storm event (FEIS Appendix A11).

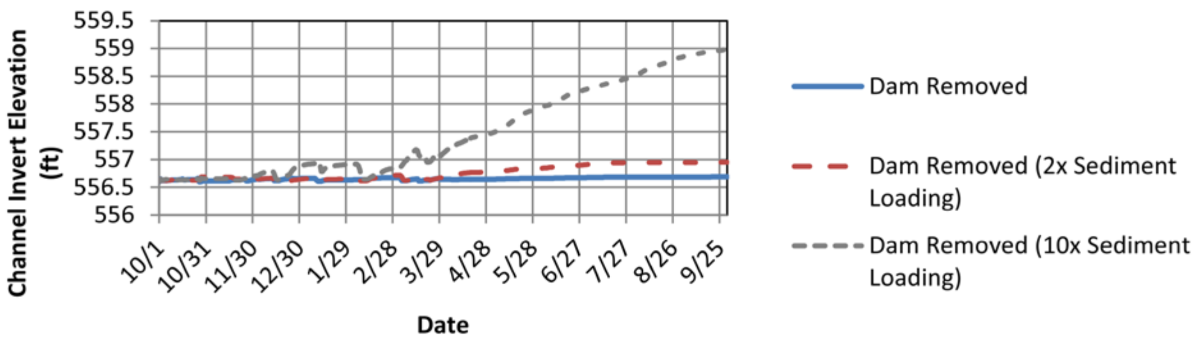


Figure 5-2. 2008 Water Year Channel Invert Elevation at Station 63000 (Stantec 2011). This station is located upstream of the U.S. Route 20 Bridge across the Sandusky River downstream from the levee reach of the river through Fremont.

Regardless of the sediment wedge's initial size and position, it would be expected to degrade over time as it migrates downstream and as sediment is redistributed over a larger area with each successive high flow event. The rate of wedge migration and sediment dispersal would be dependent upon the flow regime over a period of years following removal of the dam. If the dam removal is followed by a succession of high flow events, the rate of wedge migration and sediment redistribution would be more rapid. If flows are low, the channel would likely respond less quickly.

The sediment wedge would not be expected to form immediately below the dam due to the small grain size of the sediment stored in the pool, as well as the relatively steep gradient of the river reach between the dam and flood control levee section. Some sediment may deposit in the levee section during low flows, however, the absence of a floodplain (due to the levee confinement) greatly increases near bed shear stresses and stream power during higher flows. Consequently, high flow sediment transport capacity would be expected to be very high in this part of the Sandusky River. The effect of the sediment wedge diminishes with distance from the dam due to: (1) the dispersal of sediment over a larger area; (2) deposition of sediments on bars, islands, and floodplains; and (3) the export of the smallest particles to Lake Erie. The reach of the river near Brady's Island is potentially susceptible to sediment aggradation, particularly the side channel on the eastern end of the island. Short-term impacts to motorized watercraft navigation could occur in this reach near Brady's Island, and elsewhere in the lower river depending on water levels and water volumes. These impacts may inhibit movement of larger recreational boats. Smaller slip-boats such as Jon boats, canoes, and kayaks are not as likely to experience impacts. The magnitude and duration of the impacts depends heavily on precipitation events after dam removal. Sediment would be flushed through the system with 'large" rain events, but if the weather is dry, it may lead to longer periods of sediment aggradation in this area.

Impacts to navigation in the Sandusky River, Muddy Bay, and Sandusky Bay may be placed in perspective by comparing the sediment volume stored by Ballville Dam to the total surface area available for deposition. Based on the analysis described in Section 4.1.2.1.2, and on other studies of dam removal, if it is assumed that approximately half the sediment stored would be mobilized and exported during dam removal, roughly 470,400 CY (consistent with Major et al. 2012), and that sediment would deposit on less than ¼ of the surface area of average flow wetted stream channel available, resulting in a depth of deposition of approximately 3/8 of an inch (1 centimeter). Consequently, it is unlikely that the Ballville Dam removal would cause long term impacts to navigation. It is also important to recognize the sediment loading from removal of the dam in comparison to loading from the Sandusky River watershed. It is currently estimated that 840,000 CY of sediment are stored in the impoundment (Stantec 2011). Between 1979 and 2002, the Sandusky River watershed delivered 8,828,000 CY yards of sediment to the USGS Gauge 0419800 located at Tindall Bridge. Although events do occur in the Sandusky River where approximately 867,000 CY were delivered by the watershed in a single year and 143,000 CY in a single day (Stantec 2011), the mean annual load is approximately 368,000 CY, nearly half the estimated volume of material currently stored in the impoundment (840,000 CY). While dam removal would contribute sediment to the river, Muddy Bay, and Sandusky Bay, the load added by construction activities at the dam site would remain within the natural range of variation for the watershed recorded for most years. Sandusky Bay is periodically dredged for navigation. Currently, the USACE is planning to conduct maintenance dredging of shipping lanes in the eastern part of the Bay near the Lake Erie connection in 2014. It is not expected that the Proposed Action would impact these actions or accelerate the dredging schedule based on the natural range of variation in the watershed.

The Sandusky River's hydraulic conveyance would be bound by the bedrock river bottom and a new incision channel through the sediment stored behind the dam. The Proposed Action would provide a small level of assistance in training of the river and creating a new thalweg (i.e. line of lowest elevation within a watercourse); however, the channel would determine its own course based on water volume and velocity. It is expected that the river would be confined to its historic channel between the existing banks although may not stabilize its location for several storm events, seasons, or years.

In addition to the potential impact of releasing sediment downstream, it is important to consider the quality of those sediments and any contaminants or chemicals they may introduce long term as they travel to downstream environments. As such, Section 4.1.2.1.3 describes two independent rounds of sediment testing completed on the sediment impounded by Ballville Dam. After analyzing the results, the concentrations of contaminants do not appear to be at levels that would cause adverse environmental effects if the Ballville dam was removed. The maximum detected concentrations of organochlorine pesticides and PCBs did not exceed any SQGs. Individual metal concentrations fell below either the PECs or the Huron-Erie Lake Plateau Sediment Reference Value (SRV) and the average concentrations of all the metals were below the TELs, TECs or SRVs. The maximum detected concentrations of most analyzed SOCs fell below the PECs with the exception of acenaphthene, benzo(a)anthracene, dibenz(a,h)anthracene, fluoranthene, and phenanthrene. The total PAH concentration is below the PEC for total PAHs and the average concentrations of all SOCs fall below their respective PECs.

In addition, the sediment samples collected in the impoundment above the Ballville dam were not statistically different than those below the dam with the exception of aluminum, arsenic, barium, iron, manganese, and nickel, but the concentrations for these metals fell below either the PECs or the Huron-Erie Lake Plateau Sediment Reference Value (SRV) and the average concentrations of all the metals were below the TELs, TECs or SRVs.

The conclusion from the evaluation of the results from the supplemental sediment sampling is that the removal of the Ballville dam would not cause adverse environmental effects due to contaminants contained in the sediment.

In addition to sediment testing and sediment movement, Western Lake Erie aquatic ecosystems have had recurring HABs in recent years, and understanding long term impacts from the Proposed Action on the production of HABs is pertinent to the consideration of this alternative. To ensure an accurate assessment of this important potential impact, experts from Ohio State University, University of Toledo, Bowling Green State University, Heidelberg University and Defiance College were independently asked to review and consider this concern. Their responses indicated that removing the Ballville Dam and the release of impounded sediments will not impact cyanobacterial blooms in Sandusky Bay or Lake Erie proper.

5.1.2.3 Mitigation Measures

The Proposed Action would result in short-term increases in suspended solids concentrations that may impact aquatic organisms in downstream reaches of the Sandusky River and potentially into Lake Erie. However, these concentrations are not expected to occur at levels over concentrations which have been observed routinely in the river over the past 50 years (Stantec 2011; FEIS Appendix A11). Further, impacts to the lower Sandusky River and Lake Erie would be minimized through the timing of the demolition.
Demolition activities expected to release sediment into the river would be carried out at the beginning of the wet season, anticipating sufficient flow rate to assist with sediment transport;

and when ambient concentrations are already high to reduce the likelihood of an abrupt environmental change or shock to the lower river.
The demolition schedule for the Proposed Action has been designed such that sediment releases would occur during cooler months of the year when the metabolic demand of aquatic organisms is low and oxygen saturation in the water would be higher than during summer. This would assist in minimizing respiratory distress that might occur from elevated suspended solids concentrations. Also, many aquatic insects, amphibians, and other organisms would be entering periods of dormancy (e.g., pupation, aestivation, etc.) during the cooler months of the year.

Consequently, impacts to water quality would be expected as a result of the Proposed Action. However, these are minimized by the short-term nature of the planned ICS construction and phased notching and demolition, as well as the use of BMP’s to reduce sedimentation during construction.

5.1.3 Alternative 1 – No Action Alternative

5.1.3.1 Construction Effects

The No Action Alternative is not expected to impact existing water quality. A negligible amount of sediment could pass through the sluice gates during their rehabilitation; however, the volume would be small and pass easily in the system to settle out. It is expected that the No Action Alternative would not directly impact water resources from their current conditions.

5.1.3.2 Post-Construction Effects

Operation of the dam would be similar to current operation conditions with the exception of annually opening the sluice gates to ensure their functionality. There would be no improvements to water quality and the Sandusky River would continue not to meet its designated beneficial use for aquatic life. Further, the impoundment would continue to periodically experience algal blooms. Opening of the sluice gates may result in short discharges of sediment. However, discharges are expected to be negligible. Operation of the dam would be in compliance with ODNR Dam Safety standards and the Clean Water Act and Rivers and Harbors Act. The dam would continue to impact water quality by continuing to be a barrier to natural hydrological processes and sediment transport.

5.1.3.3 Mitigation Measures

Impacts to the lower Sandusky River and Lake Erie would be minimized through the timing of the rehabilitation. Rehabilitation activities expected to release sediment into the river would be carried out when ambient concentrations are already high to reduce the likelihood of an abrupt environmental change or shock to the lower river; and at the beginning of the wet season, anticipating sufficient flow rate to assist with sediment transport Best Management Practices (BMPs) and acceptable maintenance procedures would be used to reduce or eliminate anticipated undesirable effects. Additionally, any maintenance in the Sandusky River would require a USACE Dept. of Army Permit (Section 404 Clean Water Act and Section 10 Rivers and Harbors Act) and State of Ohio Water Quality Certification by OEPA (Section 401 Clean Water Act). All terms and conditions would be followed to minimize or avoid impacts to water resources.

5.1.4 Alternative 2 – Rehabilitate Dam, Install Fish Passage Structure

5.1.4.1 Construction Effects

The Fish Passage Structure Alternative is not expected to impact existing water quality. A negligible amount of sediment could pass through the sluice gates during their repair; however, the volume would be small and pass easily in the system to settle out. Additionally, work completed at the north abutment such as the installation of the sort/count facility, lifting system and trap system would be completed during low flows and proper sediment management and construction material management would be in place to prevent discharge downstream. It is expected that this alternative would not directly impact water resources from their current conditions.

5.1.4.2 Post-Construction Effects

Operation of the dam would be similar to current operation conditions with the exception of annually opening the sluice gates to ensure their functionality and operation of the fish elevator from March to July. No impacts to water quality are expected as a result of operation. Opening of the sluice gates may result in short discharges of sediment. However, discharges are expected to be negligible. Operation of the dam would be to ODNR Dam Safety standards and in compliance with Clean Water Act and Rivers and Harbors Act.

5.1.4.3 Mitigation Measures

Impacts to the lower Sandusky River and Lake Erie water quality would be minimized through the timing of the rehabilitation and construction. Rehabilitation activities expected to release sediment into the river would be carried out when ambient concentrations are already high to reduce the likelihood of an abrupt environmental change or shock to the lower river; and at the beginning of the wet season, anticipating sufficient flow rate to assist with sediment transport Best Management Practices (BMPs) and acceptable maintenance procedures would be used to reduce or eliminate anticipated undesirable effects. Additionally, any maintenance in the Sandusky River would require a USACE Dept. of Army Permit (Section 404 Clean Water Act and Section 10 Rivers and Harbors Act) and State of Ohio Water Quality Certification by OEPA (Section 401 Clean Water Act). All terms and conditions would be followed to minimize or avoid impacts to water resources.

5.1.5 Alternative 3 – Dam Removal with Ice Control Structure

5.1.5.1 Construction Effects

The impacts under alternative 3 would be similar as those described under Section 5.1.2.1 for the Proposed Action. However, significantly Alternative 3 is designed to construct the ICS and remove the dam in as short a time period as possible, therefore the quantity of sediment impounded by Ballville Dam would be released over a shorter timeframe and without seeding and bank stabilization. With dam removal in a single phase, the upstream channel within the former pool would be expected to respond to this new elevation with a series of adjustments such as upstream knickpoint migration, incision, and subsequent below water channel widening (Schumm and Parker 1973, Womack and Schumm 1977). This cycle of knickpoint migration, incision, and widening would likely occur repeatedly until a new stable bed elevation is achieved along the length of the impoundment to the new elevation at bedrock. Fine-grained sediments would be mobilized and exported to downstream reaches during and immediately after construction associated with removal. A pulse of stored sediment expected to be larger than the Proposed Action in magnitude initially due to the short time period of removal would be exported to downstream reaches during the demolition process. Subsequent pulses would be mobilized during storm generated high flow events.

5.1.5.2 Post-Construction Effects

Post-construction effects would be similar to those described in the Proposed Action, Section 5.1.2.2. Alternative 3, however, is designed to be executed in a shorter time period, and there would be less time to allow the sediment in the former impoundment to stabilize. Additionally, there would be more potential to export sediment from the former impoundment immediately following dam removal, flushing more sediment downstream over a shorter time period. There would likely be greater aggradation of sediment downstream of the dam in this alternative, because sediment would be mobilized in one event without a period of time to become stabilized.

5.1.5.3 Mitigation Measures

Alternative 3 would result in short-term increases in suspended solids concentrations that may impact aquatic organisms in downstream reaches of the Sandusky River and potentially into Lake Erie. The impacts of this alternative would be expected to be greater in magnitude when compared with those expected under the Proposed Action due to the single phase approach to dam removal and sediment release. However, these concentrations are not expected to occur at levels over concentrations which have been observed routinely in the river over the past 50 years (Stantec 2011; FEIS Appendix A11). Further, impacts to the lower Sandusky River and Lake Erie would be minimized through the timing of the demolition.

Demolition activities expected to release sediment into the river would be carried out at the beginning of the wet season, anticipating sufficient flow rate to assist with sediment transport; and when ambient concentrations are already high to reduce the likelihood of an abrupt environmental change or shock to the lower river.

The demolition schedule has been designed such that the sediment release would occur during cooler months of the year when the metabolic demand of aquatic organisms is low and oxygen saturation in the water would be higher than during summer. This would assist in minimizing respiratory distress that might occur from elevated suspended solids concentrations. Also, many aquatic insects, amphibians, and other organisms would be entering periods of dormancy (e.g., pupation, aestivation, etc.) during the cooler months of the year.

Consequently, impacts to water quality would be expected as a result of Alternative 3. However, these are minimized by the short-term nature of the planned ICS construction and demolition phase, as well as the use of BMP's to reduce sedimentation during construction.

5.2 WILDLIFE AND FISHERIES (FISH AND AQUATIC HABITAT)

5.2.1 Impact Criteria

As described in Section 2.1, the potential impacts of the Proposed Alternative on downstream habitats due to sediment release is one of the concerns identified as a focus of this Final SEIS. As such, below is a description of the analysis in relation to environmental consequences by alternative specific to the aquatic populations within the Project Area and within the larger section of the Sandusky River and its riparian borders within the Project Area. This analysis considers:

- Assessment of effects to fisheries resources, in legal, commercial, recreational, ecological or scientific terms;
- The proportion of resources that would be affected, relative to their abundance in the region;
- The sensitivity of the resources to proposed activities; and
- The duration of the ecological consequences.

Specifically, effects on fisheries resources would be significant if important species or habitats (i.e., species or habitats considered significant by state or federal natural resource agencies) were adversely affected or substantially benefitted over relatively large areas; or if the Proposed Action or alternatives cause substantial reduction or substantial increase in population size or distribution of an important species. The estimated duration of an impact also affects its significance level.

5.2.2 Proposed Action

5.2.2.1 Construction Effects

The Proposed Action construction is segmented into phases; each with sub-phases designed to complete the project in the least environmentally damaging way. Phase 1 would remove a small section of the dam resulting in a "notch" in the south spillway of Ballville Dam that is 20 feet wide and 10 feet tall.

Notching of the dam would allow concrete to fall into a scour hole directly at the toe of the dam. This could result in some incidental fish mortality; however, the vibration of the hoe-ram notching the dam is expected to cause fish to move away from the location where concrete would fall. Additionally, notching of the dam would result in the export of some sediment currently stored behind the dam (FEIS Appendix A11). The magnitude of sediment export would be limited by the relatively small hydraulic capacity of the notch (Riggsbee et al. 2007). The discharge of sediment during phase I (notching of the dam) is not expected to impact aquatic habitats downstream as the concentration of sediment estimated to be brought into suspension would not exceed normal conditions for the lower Sandusky River during high water events. While aquatic insects and mussels are mobile to some extent, and given time may migrate from some of the unsuitable areas, benthic organisms present in the impoundment are expected to be adversely affected by lowering the pool. Aquatic insect assemblages below the water line would recover quickly as a result of the upstream supply of drifting animals. They would soon consist of organisms that utilize riverine habitats rather than lentic assemblages currently present. Previous studies on the effects of dam removals on macroinvertebrate communities suggest that macroinvertebrate assemblages downstream of a dam can experience a reduction in abundance after the impounded sediment is released (Crosa et al. 2010); however, communities have been known to recover in a relatively short amount of time (three months to two years [Crosa et al. 2010; Maloney et al. 2008]). Additionally, a lotic assemblage of macroinvertebrates can replace a lentic assemblage in former impoundments within one to two years after dam removal (Stanley et al. 2002; Maloney et al. 2008). Aquatic benthic organisms would no longer be able to use the exposed shore line flats and these areas would begin transitioning to riparian forests. Impacts to freshwater mussels would be minimized by capturing and relocating stranded freshwater mussels to locations outside of the drawdown area. Relocation of mussels would be consistent with agency approved study plans.

Both the notch phase and the dam removal phase of the proposed action will likely mobilize currently impounded sediment. As described in the FEIS appendix A11, the influence of suspended sediment concentrations on freshwater mussel distribution and abundance has been infrequently researched. Bucci et al. (2008) conducted laboratory experiments on freshwater mussel feeding at various suspended sediment concentrations. They found that valve gape (an indication of feeding activity) for fat muckets (*Lampsilis siliquoidea*) during periods of low (<20 NTU) and high turbidity (20 – 75 NTU) did not differ significantly, whereas valve gape for the invasive Asiatic clam (*Corbicula fluminea*) did. The experimental concentrations did not reach levels sufficient to cause valve closure in the fat mucket. However, the test concentrations were higher than those observed during base flow for the three case studies where NTU values were reported (Granata et al. 2008, Sethi et al. 2004, Majors et al. 2012) suggesting that normal feeding for this species would not be impaired by the Proposed Action.

Beussink (2007) exposed fish, infested by larval mussels (glochidia), to high concentrations of suspended sediment ranging between 1,000 and 5,000 ppm for a 48 hour period. Increased sediment concentrations resulted in reduced gill attachment and metamorphosis rates. Sediment treatments equal to 5,000 ppm often, but not always, resulted in greater than 90 percent mortality for the glochidia. However, glochidial metamorphosis rates for lesser sediment concentrations ranging between 1,000 and 2,500 ppm were often statistically indistinguishable from experimental controls (0 ppm). The exact threshold for the lethal effect was not determined in this study but is likely higher than the maximum observed concentration in the Sandusky River (2,420 ppm) for the period between 1979 and 2002.

One plausible mechanism for adversely affecting freshwater mussels through the Proposed Action is burial by increased sediment load. Marking (1979) (as cited in Watters 1999) found that 50 percent of fat muckets and pocketbooks (*Lampsilis cardium*) could successfully extricate themselves when buried in sediment to a depth of nearly seven inches. A similar proportion of Wabash pigtoes (*Fusconaia flava*) self-extricated from a depth of only four inches, an indication of the differential abilities among species. Krueger et al. (2007) experimentally buried mussels under nearly 16 inches of sediment and observed between six and 13 percent mortality after 48 hours. The exact cause of mortality was not determined but was probably sediment anoxia. Sheldon and Walker (1989) studied two freshwater mussel species in a laboratory setting and found differential susceptibility to low oxygen concentrations between species that primarily occur in lentic (lake like) habitats and those that occur in lotic (flowing water) habitats. Species that rely on riffles, runs, and other habitats with fast flowing oxygenated water were less able to tolerate low oxygen concentrations.

Lewis and Reibel (1984) studied the burrowing behavior of three mussel species in liquefied mud, compacted clay, sand, and washed gravel. Animals placed on their side in liquefied mud had difficulty turning to an upright digging position but were able to burrow as a result of depressions caused by the weight of the animal and frequent expulsion of water from the siphons. Rates of burrowing in the remaining substrates varied by species and grain size with the burial depths the lowest in the coarsest substrates. Nonetheless, the mussels were able to bury in widely divergent substrate types, indicating a high degree of adaptability to the varied conditions that mussels inevitably encounter in natural settings. These results confirm the work of Strayer (1981) and Hardison and Layzer (2001) among others documenting the flexible use of substrates by mussels.

Some burial and subsequent mortality of freshwater mussels in the low gradient reaches of the Sandusky River below the dam is probable, especially in areas susceptible to sediment aggradation. However, field and laboratory studies demonstrate that mussels can endure substantial deposition and in some cases levels that are greater than anticipated for the Proposed Action. It is also clear that mussels occur in a wide range of substrate size classes. Release of sediments from Ballville Dam would likely cause temporary reduction in sediment grain sizes in the reach downstream of the dam. If the extent of deposition is modest, then resident animals should be able to adapt to the changing conditions.

Few studies have directly examined the impact of dam removal on downstream mussel populations. Sethi et al. (2004) studied the response of a rapid dam breach on habitat and mussels in Koshkonong Creek in Wisconsin. Unfortunately, the experimental design did not include a control site so the results are difficult to interpret. The authors found that the total area of substrates comprised of silt and sand increased significantly over pre-project levels. This effect did not occur immediately but was observed nearly three years after the dam removal. Total mussel density did not differ from pre-project levels three months after the dam breach but was significantly lower in the third summer after removal. However, because of issues with the experimental design it is difficult to discern whether this decline was related to the dam removal, to natural population variability, or to factors related to search efficiency (e.g., river discharge, visibility, etc.).

More recently Heise et al. (2013) studied the effect of dam removal on mussel populations in the Deep River in North Carolina. This project differed from the one described in Sethi et al. (2004) in several ways. First, drainage area for the study site on the Deep River was an order of magnitude larger, the dam stored little sediment, and the drawdown occurred over weeks rather than hours. The authors observed short-term increases in fine-grained substrates in the year following the dam removal but sample locations returned to pre-project values in the second year of sampling. None of the mussel community metrics studied, including mussel density and species richness, detected significant effects from the dam removal.

Because of the emphasis on sediment control measures proposed for the Ballville Dam Project, it is anticipated that effects to downstream mussel populations, if any, would be short-term. Further, any adverse impacts would be offset by restored riverine habitat, elimination of a migratory barrier for fish (host) movement, and increased genetic exchange between isolated upstream and downstream populations. Further, both phases of demolition would be scheduled for the fall when stream temperatures are low and metabolic demand by mussels would also be low (Myers-Kinzie 1998) thereby minimizing the potential for physiological stress and mortality.

After Phase I, approximately 20 acres (8.1 hectares) of newly exposed sediment previously inundated by the impoundment would be exposed during the drawdown. Stabilization measures may include aggressive seeding and vegetation strategies to supplement the existing seed banks within the sediment to establish a hearty vegetative cover over exposed areas susceptible to erosion, consistent with the Planting Plan described in the FEIS.
A second access road from the north side of the river would be developed to continue demolition of the structure. This would provide access from both the American Electric Power storage yard adjacent to the dam and from County Road 501. Impacts to fish and aquatic habitats would be minimal due to this element of construction.

A cycle of knickpoint migration, incision, and widening would likely occur as part of the demolition resulting in the export of a pulse of sediment to downstream of the dam. This cycle would occur repeatedly until a new stable bed elevation is achieved along the length of the impoundment. Subsequent sediment pulses would be mobilized during storm generated high flow events. The impoundment would no longer constrain the physical forces necessary to mobilize and transport coarse-grained substrates. Fish and freshwater mussels would likely be exposed to increased suspended sediment concentrations. Prior studies of suspended sediment concentrations and dam removals indicate that concentrations may initially be high during the breaching of the dam but that concentrations quickly decline to approach background concentrations. Other periods of elevated concentrations occur associated with storm events and high flows. Thus impacts to water quality would consist of a series of punctuated periods of elevated concentrations that may occur over a period of one to three years (Sethi 2004, Riggsbee et al. 2007, and Major et al. 2012). Fish communities evolved to tolerate increased concentrations for short periods. Since anticipated concentrations from releases would be within the range of natural variability, any adverse effects of increased suspended sediments are expected to be temporary and short-term.

Construction of the ICS would temporarily exclude aquatic species and limit habitat. Due to the mobility of fish no direct impacts resulting in death are expected. Additionally, ICS construction activities would occur during periods when resident and migratory fish densities are low for this part of the Sandusky River. Displacement of fish would be temporary and fish are expected to quickly recolonize the area. Some fish would likely benefit from the structural habitat provided by the ICS, as the bedrock reach immediately below the dam is often uniform habitat. Construction activities and the associated noise may cause some temporary displacement of fish. However, fish may acclimate to the noise over time and may re-occupy habitats in the demolition area. Noise and demolition impacts would be limited to a discrete area and adverse effects would be mitigated by the beneficial elements of the project such as increased fish passage. The exposed bedrock in the area immediately below the dam provides very poor habitat and no live mussels were found during 2011 surveys. Consequently mussels should not be adversely affected by ICS construction activities. Construction would include drilling shafts and pouring concrete by tremie method. This is proposed to occur during low flow times of the year (July –October).

Completing Phase II would be the channel grading of the Sandusky River. Expected to occur between November and December 2017, this action would reshape the channel and establish a floodplain on the north side of the river. This would result in short-term increases in suspended sediment concentrations for the duration of the channel work. This may trigger avoidance behaviors by some fish species; however, concentrations are not expected to exceed those generated by storm events. Stabilization measures would be used to minimize erosion. The grade of the river would be restored to a condition that would allow for migratory aquatic species to access nearly 20 miles (32.2 kilometers) of new habitat.

5.2.2.2 Post-Construction Effects

Beneficial impacts associated with the Proposed Action are likely to result in the presence of increased numbers of forage fish, as represented by adult and juvenile migratory species upstream from the dam. Changes to the fish population would likely benefit wildlife such as river otter, bald eagle, osprey, and kingfisher by providing a larger and more diverse forage base. Ponded open water habitat that exists behind the dam would be eliminated once the dam is removed and shift to its historic riverine habitat type.

As described in the FEIS appendix A11, Hesse and Newcomb (1982) studied the impact of flushing (sluicing) reservoir sediments on water quality and fish populations in the Niobrara River in Nebraska. In October 1976 reservoir flushing increased suspended sediment concentrations in the river. Turbidity was measured at 3,750 Jackson Turbidity Unit[2] (JTU), total suspended solids measured 21,875 ppm, and a fish kill was documented. Low dissolved oxygen concentrations were also implicated as a contributing factor in the fish kill. Subsequent monitoring between June and September of 1979 measured turbidity as high as 2,075 JTU and total suspended solids as high as 14,540 ppm without a fish kill. The maximum observed concentration in the Sandusky River between 1979 and 2002 was 2,420 ppm, far lower than concentrations described above. Further, the reservoir flushing on the Niobrara River produced concentrations six times higher than those observed on the Sandusky River without a fish kill. Hydraulic modeling suggests that concentrations for the Ballville Dam Proposed Action would be expected to range between 50 and 500 ppm (Stantec 2011), therefore lethal effects to fish from physiological stress are not expected.

The demolition schedule for the Proposed Action has been designed such that sediment releases would occur during the cooler months of the year when the metabolic demand of aquatic organisms is low and oxygen saturation in the water would be high. This would assist in minimizing any respiratory distress that might occur from elevated suspended solids concentrations. Also, many aquatic insects, amphibians, and other organisms would be entering periods of dormancy (e.g., pupation, aestivation, etc.) during the cooler months of the year.

The potential for feeding impairment resulting from release of Ballville Dam sediments depends on the (1) physiological capabilities and the lifestage of the organism under consideration and (2) the ambient concentrations delivered by the proposed project. Some organisms prosper under elevated suspended sediment concentrations. For example, Walleye have a special layer in the retina that is extremely sensitive to light thereby enabling adult Walleye to forage for prey in dark and/or turbid environments that cannot be exploited by competitors (Kerr et al. 1997, Hartman 2009). However, there are limits to this ability. In a review of available literature, Kerr et al. (1997) concluded that Walleye foraging could be impaired at suspended sediment concentrations ranging between 200 and 300 ppm. Further, not all life stages are equal and younger fish are widely viewed as being more susceptible to stressors than adult fish. Walleye and Yellow Perch were reared as fingerlings for 28 days under a clear water and turbid treatment (>= 100 NTU) (Clayton and Morris 2009). Yellow Perch exhibited greater survival (79 +- 2.1%) under the turbid treatment than in clear water (54 +- 9.2%). Walleye survived better in clear water treatment (83 +- 2.0%) than in the turbid treatment (57 +- 6.0%). Mion et al. (1998) demonstrated reduced larval Walleye survival in the Maumee and Sandusky River associated with high river and sediment discharge.

Sensitivity to suspended solids also varies between species. For example, Walleye and Smallmouth Bass are classified as moderately tolerant to turbidity while other species that may be present in the project area, such as Silver Redhorse (*Moxostoma anisurum*) and Shorthead Redhorse (*Moxostoma macrolepidotum*) are intolerant of prolonged high turbidity (Trebitz et al. 2007). Unfortunately we were unable to obtain any studies characterizing suspended sediment thresholds for intolerant non-game species. Others, such as the Common Carp (*Cyprinus carpio*), Yellow Perch, Gizzard Shad (*Dorosoma cepedianum*; Gonzalez et al. 2010), apparently thrive on elevated suspended sediment concentrations and are often found in waters where average low flow turbidities exceed 100 NTU.

Prior studies of suspended sediment concentrations and dam removals indicate that concentrations may initially be high during the breaching of the dam but that concentrations quickly decline to approach background concentrations. Other periods of elevated concentrations occur associated with storm events and high flows. Thus impacts to water quality will consist of a series of punctuated periods of elevated concentrations that may occur over a period of one to three years (Sethi 2004, Riggsbee et al. 2007, and Major et al. 2012).

Reproductive success may be adversely affected by the Proposed Action through (1) burial of eggs from increased sediment loads, (2) increased suspended sediment concentrations that interfere with egg metabolism, and (3) increased suspended sediment concentrations that interfere with fish behavior. Comprehensive egg burial studies exist for salmonids and some estuarine species (Newcombe and Jensen 1996) but are lacking for species known to occur in the project area. Jennings et al. (2010) examined incubating Robust Redhorse (*Moxostoma robustum*) eggs in substrates in laboratory tanks with varying degrees of fine sediment (between zero and 75 %) to determine if there was a threshold of deposition that was harmful to egg survival. Mean intragravel dissolved oxygen concentrations were higher in the zero and 25 percent treatments (7.5 to 7.6 ppm) than the 50 and 75 percent treatments (6.3 to 7.5 ppm). Survival to emergence was highest in the treatment without fine sediment (35 to 80 %), declined rapidly for the 25 percent treatment (0 to 20 %), and was essentially zero in the highest concentration treatments. While the Robust Redhorse does not occur in the project area, its behavior and habitat selection is similar to other extant redhorse species (e.g., Greater, River, Black).

Ambient water concentrations rather than substrate conditions are relevant to egg incubation and survival for species that deposit eggs on the surface of the stream bed or attach them to vegetation or other surfaces. Walleye eggs exposed to suspended sediment concentrations of 0, 100, 250, and 500 ppm showed no significant effects on survival (Suedel et al. 2012). In contrast, Gray et al. (2012) found that incubating Spotted Gar eggs had higher hatching success in clear water (94.8 % of eggs) versus experimentally manipulated turbid water (72.2 % at 5.5 NTU).

In addition to physiological effects, high suspended sediment concentrations may also affect reproductive behaviors. Sutherland (2007) exposed eggs of the crevice spawning minnow the

Whitetail Shiner (*Cyprinella galactura*) to pulsed suspended sediments with concentrations of 0, 25, 50, 100, and 500 ppm. Spawning effort was affected at concentrations as low as 50 ppm and did not occur in four of the seven high concentration replicates. Based on the developmental state of the eggs it was also clear that reproduction was substantially delayed in the 100 and 500 ppm treatments.

Adverse impacts to reproduction will be avoided, to some degree, through the timing of the Proposed Action. Both the dam notch and complete dam demolition would occur in the fall, months before spring reproduction. Sediment released from construction activities and the subsequent winter storm events would occur at a time when eggs are not present in the Sandusky River. Sediment mobilized in spring storm events could possibly increase egg exposure to elevated sediment concentrations. The eggs of at least one species (Walleye) have demonstrated a fairly robust tolerance for elevated suspended solids concentrations and should not be affected by concentrations expected from the Proposed Action. Behavioral modification may be expected in some species as a result of high concentrations associated with storm events. However, storm generated concentrations are already high under the base line scenario and fish species in the project area and behavioral responses exhibited at present should not differ substantially from those expected with the Proposed Action. It is also important to recognize that impacts from the dam are temporary. Beneficial elements of the Proposed Action, such as increased fish passage, would be more permanent. Walleye, in particular, would benefit from an additional 22 miles of spawning habitat.

Major negative changes to structural habitat quality are not anticipated downstream of the dam. High gradient bedrock and cobble reaches, due to their high transport capacity, would experience little change in substrate composition or embeddedness as a result of the dam removal. Current Walleye spawning habitat should not be negatively affected by sediment releases (Stantec 2011). In fact, these areas may be enhanced through restoration of coarse sediment supply from the upper watershed. It is unlikely that coarse sediments have passed below the dam in more than 100 years. Low-gradient reaches may experience aggradation associated with the sediment wedge described above. The spatial and temporal extent of this impact is currently unknown. However, adverse effects are expected to be short-term and temporary. Prior dam removal studies suggest that the duration of impact could be one to three years.

Although fish communities can be adversely impacted by increased turbidity after a dam removal, the impacts will be temporary. Maloney et al. (2008) studied the impacts of a dam removal on the fish community in the Fox River in Illinois. Three years after the dam removal, the fish community shifted toward, but had not completely become, lotic. Former impoundments often lack instream structures (i.e. woody debris and boulders) and spawning habitat (coarser substrates, aquatic macrophytes) following dam removal. Kanehl et al. (1997) stated that it may take as long as five years for a former impoundment to show improvements in recovery following a dam removal. As impoundments revert to a free flowing state, additional restoration practices may be required to hasten the shift from a lentic to lotic habitat system (Maloney et al. 2008).

Studies of riverine impoundments typically document simplified fish communities as a result of poor habitat conditions (e.g., sediment anoxia, absence of spawning habitat, depressed macroinvertebrate production, and poor water quality). After the Woolen Mills Dam on the Milwaukee River in Wisconsin was removed, Smallmouth Bass increased in the stream reach due to the reintroduction of coarser sediments to the river (Kanehl et al. 1997; Nelson and Pajak 1990). Furthermore, more Smallmouth Bass spawning habitat became available following the dam removal (Staggs et al. 1995). Burroughs et al. (2010) examined the impacts of the removal of the Stronach Dam on the fish assemblage of the Pine River in Michigan. After the removal, eight fish species formerly restricted to areas downstream of the dam migrated to newly accessible areas upstream of the dam. Eighteen of the 25 species evaluated showed an increase in number after the removal, suggesting that dam removal may increase habitat availability for riverine fishes (Burroughs et al. 2010). Stantec (2012) observed that the biomass of sensitive intolerant species, such as River Redhorse and Black Redhorse, increased by an order of magnitude only two years after removal of Englewood Dam on the Stillwater River in Ohio.

Fish may be temporarily adversely affected by increased sediment loads and the subsequent physiological stress from high suspended sediment concentrations, feeding impairment, reproductive impairment, and changes to structural habitat quality (FEIS Appendix A11). However, these impacts appear to be temporary and recovery is generally underway or complete within three to five years (Doyle et al. 2005). The greatest benefit of dam removal and installation of the ICS would be realized by aquatic species and particularly migratory fish. A diverse fish community of 88 native species has used the river and bay system for some or all of their life stages, including Walleye, White Bass, Channel Catfish, Smallmouth Bass, Redhorse Suckers, Buffalo, and Northern Pike (Bogue 2000). Removal of the dam and installation of the ICS is expected to increase their numbers by promoting more access to spawning habitat upstream of where the dam previously was located.

Walleye and White Bass support important spring river fisheries in the Sandusky River. Although current migratory Walleye and White Bass stocks that reproduce in the Sandusky River support a smaller percentage of the overall fishery in Lake Erie, the removal of the dam is expected to significantly expand the available spawning habitat leading to the potential for increased abundance overtime. An additional 22 miles (35.4 kilometers) of the Sandusky River would be opened to migratory fish species including Walleye, White Bass, and the State-threatened Greater Redhorse. Riverine Walleye populations in the Sandusky system are currently constrained by access to approximately 20 acres (8.1 hectares) of spawning habitat. Access to Ballville Dam upstream to Bacon Mill Dam, would increase available spawning habitat to approximately 300 acres (121.4 hectares)(Jones et al. 2003).

Jones et al. (2003) suggests that the removal of Ballville Dam along the Sandusky River would help improve the Lake Erie Walleye population by reconnecting 22 miles (35.4 kilometers) of free-flowing river to Lake Erie and providing Walleye access to new spawning habitat. Jones et al. (2003) also indicates the 300 acres (121.4 hectares) of additional of spawning habitat could produce between 10,000,000 and 149,000,000 larval fish on an annual basis. This yield would be on average eight times greater than the Walleye yield in the habitats below the dam (Jones et al. 2003).

Other native species are expected to benefit from dam removal and increase their abundance as well. For example, increased connectivity between critical habitats for Sauger (*Sander canadense*) resulting from removal of Ballville Dam may make it possible to re-establish this species in the basin. The Freshwater Drum, an important host species for freshwater mussels, was collected downstream but not upstream of the dam in a previous study which may indicate improved habitat access for them as well (OEPA 2011a). An improved river flow regime with open access to substantially more habitat as a result of dam removal should provide benefits to virtually all native aquatic species, as well as improving biodiversity when compared to present conditions both above and below Ballville Dam.

The Proposed Action would cause short-term, temporary increases in sediment load downstream of the current dam location. Potential effects to freshwater mussels include physiological stress from elevated suspended sediment concentrations and habitat changes resulting from increased sediment load. Elevated suspended sediment concentrations could interfere with mussel feeding; however, mussels have physiological adaptations that allow them to endure short term environmental stressors (Sheldon and Walker 1989, Haag 2012) such as those expected for the Proposed Action. Some burial and subsequent mortality of freshwater mussels in the low gradient reaches of the Sandusky River below the dam is probable, especially in areas susceptible to sediment aggradation. However, field and laboratory studies demonstrate that mussels can endure substantial deposition and in some cases levels that are greater than anticipated for the Proposed Action.

It is expected that removal of the dam would benefit mussel habitat in the areas upstream of the dam and downstream. Coarser sediments (cobble, gravel, and sand) would replace the silt dominated substrate in many sections of the impoundment although much of the substrate of the pooled area is expected to convert to bedrock. Some mussel habitat may be created on the margins of the channel but the primary benefit to mussels is the movement of host fish. The proposed action would eliminate a migratory barrier for fish and increase genetic exchange between isolated upstream and downstream mussel populations (Watters 1999).
The ICS would not act as a barrier to fish during spawning periods. The ICS was modeled using the Hydrologic Engineering Centers River Analysis System (HEC-RAS) to help determine if the piers themselves would cause elevated flow and thereby act as a velocity barrier. The model took into account that Walleye burst swimming speed ranges between 5.25 and 8.5 feet (1.6 and 2.6 meters) per second (Peake et al. 2000). At velocities between 500 and 2,500 cfs it was modeled that between 33 and 42 percent of contiguous block flows (i.e. flows between neighboring piers) are less than 5.25 feet / second (1.6 meters / second) thus allowing for Walleye to move past the ICS during migration.

Although the Proposed Action does provide fish passage opportunities for many native species it also removes a barrier to potential invasions by non-native aquatic nuisance species. With

possibly numerous new invasive species entering the Great Lakes each year, it is difficult to predict, with any certainty, which would be the next to colonize successfully and which would fail to materialize in the vicinity of Ballville Dam. However, known species such as sea lamprey and Asian Carp are two high profile species of interest relating to the proposed action.
To investigate possible impacts of sea lamprey we consulted with the Sea Lamprey Control Program within the Service. According to their study and expert analysis, “While there is lamprey spawning and larval habitat present up and downstream of the dam, we have never found any larval sea lampreys or native lampreys up or downstream of the dam. The lower portion of the river is a large estuary with low flow which may deter entrance into the river. Overall, there was not enough evidence to suggest that sea lampreys would become a problem in the river.”

Asian Carp populations are known to be moving toward the Great Lakes ecosystem from the Mississippi River Basin. Much is unknown regarding Asian Carp and their current status in the vicinity of Ballville Dam; however, three live bighead carp were captured in the western basin of Lake Erie between 1995 and 2000. Environmental DNA is one tool used to sample the environment and can help managers determine the presence of species specific DNA in the water. However, there are many possible eDNA vectors, in addition to live individuals, which could explain its presence including bird feces, boats or equipment used in multiple water bodies, contaminated sewage outputs, etc. (United States 2013, USACE 2013). Positive eDNA samples from 2011-2013 further raise awareness regarding this species and the possible risk of impacts relating to the proposed action. As described in Section 4.2.2 a risk analysis was completed to quantify this potential impact. Based on the risk analysis, experts agreed that the proposed action would not provide increased Risk Potential of Asian Carp to Lake Erie (Appendix E). However, there was mixed Expert characterization of Asian Carp Risk Potential to the Sandusky River under the Proposed Action: two of the Experts projected an increase in Risk Potential, whereas four of the experts projected no change in Risk Potential. It is also worth noting that the uncertainty levels varied amongst the six Expert panelists on this issue, but was consistent between the proposed action and the No Action Alternative. The complete results of this analysis can be viewed in the Risk Analysis Report (FEIS Appendix E).

It is probable that demolition of Ballville Dam and the subsequent increase in sediment load would represent a disturbance to aquatic ecosystems and biota downstream of the dam. Due to uncertainties regarding the magnitude, duration, and rate of transport associated with the physical response of the river to increased sediment load, it is difficult to predict the ecological response. Based on our current understanding of the physical processes at work, the disturbances would be temporary and potentially within the current range of variation for this system. Nonetheless, many studies report declines in community metrics in the years following dam removal (e.g., Sethi 2004, Maloney et al. 2008) although notable exceptions exist (Heise et al. 2013). In either case evidence from longer term studies suggest that ecosystem components recover from the episodic disturbance caused by dam removal. Doyle et al. (2005) propose a conceptual model suggesting that some organisms and/or populations would likely recover quickly from dam removal (e.g., aquatic insects) while others would potentially require longer (e.g., riparian vegetation).

In summary, the proposed action would have a long-term beneficial effect on aquatic species by opening up 22 miles (35.4 kilometers) of Sandusky River habitat that was previously inaccessible due to the presence of the dam. Short-term, minor adverse effects to some localized aquatic species may occur due to sedimentation, but these effects would be minimized by mitigation measures, and would not persist for longer than a few years. The proposed action would provide an additional vector for the movement of aquatic invasive species in the Sandusky River, although it is impossible to know with certainty which species may attempt to utilize this vector or their rate of successful establishment. We have discussed two known species of concern and their relative risk potential.

5.2.2.3 Mitigation Measures

The design for the proposed action employs the use of a notch with is intended to diminish the initial delivery of sediment to downstream reaches. The Proposed Action is an overall 26 month long project with the actual demolition of the Ballville Dam occurring in phases over a 14 month period. Construction would be timed to avoid sensitive life history windows for key species in the project area (e.g., fish reproduction, bat roosting, etc.). This approach was designed to result in the release of smaller volumes of sediment over a longer time frame (not one event). This is expected to minimize the size of the sediment wedge and the magnitude of suspended sediment associated with any given storm event (Riggsbee et al. 2007). This would also minimize potential impacts to aquatic species inhabiting areas downstream of the dam.

Demolition for the Proposed Action would be sequenced to occur in the fall, just before the onset of the wet season. The timing of construction is important because it would avoid sediment releases during the low flow, warmer summer months when water quality impacts would be the greatest and when the river has the least capacity to move sediment. This strategy would minimize the potential for physiological stress and mortality in aquatic organisms by restricting demolition to periods when stream temperatures would be low and metabolic demand would also be low.

For aquatic species, while continual demolition of the dam occurs and the drawdown of the impoundment continues, native live mussels located on the exposed ban/margins of the former impoundment would be recovered and relocated to suitable habitat in the Sandusky River upstream of the dam as quickly as possible. This activity would be coordinated with ODNR and the Service to ensure appropriate level of effort and effectiveness. Relocated mussels would be periodically monitored to determine survival rates, and a monitoring report would be provided to ODNR and the Service.

A pre- and post-project monitoring plan is in place for aquatic populations utilizing the lower Sandusky river relating to the Proposed Alternative. Pre-project monitoring characterizing the current fish community in the area around the Ballville Dam, and to quantify migratory fish abundance has been completed (OEPA 2011a; Ross 2013). Fish assessment surveys will be completed periodically into the future to quantify potential responses in the fish community.

Colonization of upstream reaches by aquatic invasive species may take years or decades, post project aquatic resource monitoring would assist in understanding what species are moving through the area and utilizing the aquatic habitat. In the event aquatic invasive species are detected, there are numerous aquatic resource management tools that could be utilized dependent on the species and their extent. For example, the Asian carp Risk Analysis Expert panel provided some ideas for practical, effective, and efficient management to control abundance and mitigate impacts of Asian carps in the Sandusky River, if they establish self-sustaining populations there. The most frequent recommendation was targeted harvest (recruitment overfishing), however the full list of ideas provided can be viewed in the Risk Analysis Report (FEIS Appendix E). Additionally, ODNR has developed an Asian Carp Tactical Plan that identifies strategies to minimize the risks of introduction of Asian carp into the Lake Erie basin, as well as explicit response plans for detection of Asian carp in Ohio waters (ODNR 2013a). Ultimately, it would be the responsibility of aquatic resource managers to monitor aquatic species to assess their status and carry out management actions as necessary.

Lastly, Best Management Practices (BMPs) and acceptable design and construction procedures would be used to reduce or eliminate anticipated undesirable effects such as soil erosion, resulting from construction that could contribute to sediment deposition. The Proposed Action would re-seed approximately 20 acres (8.1 hectares) of exposed sediment upstream of the dam with the intent to stabilize as much sediment in place as possible. Erosion control and stormwater management is required during construction through the National Pollutant Discharge Elimination System (NPDES) permitting program. Additionally, any work in the Sandusky River would require a USACE Dept. of Army Permit (Section 404 Clean Water Act and Section 10 Rivers and Harbors Act) and State of Ohio Water Quality Certification by OEPA (Section 401 Clean Water Act). All terms and conditions would be followed to ensure no significant impacts occur to wildlife and fisheries.

5.2.3 Alternative 1 – No Action Alternative

5.2.3.1 Construction Effects

The exact methods for construction are not known at this time, however, it is anticipated that some form of containment cell would be necessary upstream of the dam to dewater areas adjacent to the sluice gates. Construction associated with the containment cells could result in temporary displacement of fish and wildlife. However, thick, anoxic sediment deposits exist immediately upstream of the dam. These conditions likely cause avoidance by fish and would therefore minimize the potential for adverse impacts to fish. Work associated with the concrete repairs would also cause temporary displacement for fish and wildlife.

5.2.3.2 Post-Construction Effects

Operation of the dam would be similar to current operation conditions with the exception of annually opening the sluice gates to ensure their operation. Opening of the sluice gates may result in short discharges of sediment. Fish kills have been documented as a result of operation of sluice gates (e.g., Hesse and Newcomb 1982); however, proper management of the timing and duration of releases can minimize adverse impacts to aquatic species. It is anticipated that the sluice gates would only be opened for a sufficient duration to ensure that they would be operable. Thus, the load of sediment discharged in this time period would be negligible. The dam would continue to be a barrier to aquatic species migration and natural hydrologic and sediment transport processes in the Sandusky River.

5.2.3.3 Mitigation Measures

Rehabilitation would be completed under a USACE Dept. of Army Permit (Section 404 Clean Water Act and Section 10 Rivers and Harbors Act) and State of Ohio Water Quality Certification by OEPA (Section 401 Clean Water Act). All terms and conditions would be followed to ensure no significant impacts occur to wildlife and fisheries resources.

Sluice gates would only be opened for the minimal time necessary to demonstrate functionality. Additional gate openings could also be conducted to maintain operability. These additional openings would minimize any impacts to aquatic resources by occurring in colder weather when dissolved oxygen is highest in the water.

Operation of the dam would be to ODNR Dam Safety standards and in compliance with Clean Water Act and Rivers and Harbors Act.

5.2.4 Alternative 2 – Rehabilitate Dam, Install Fish Passage Structure

5.2.4.1 Construction Effects

Construction impacts associated with repair of the dam are the same as those described in Section 5.2.3.1. In addition, construction of the fish ladder and sorting building would also likely result in short term impacts to water quality and temporary displacement of fish and terrestrial wildlife. Impacts would result from the pouring of concrete, modification of the stream bed topography near the fishpass inlet (if necessary), and operation of heavy equipment in and near the channel. The sorting facility would be constructed in a previously disturbed area without wetlands or terrestrial vegetation and impacts are not expected. Some temporary displacement of birds and other types of urban wildlife may be expected during construction.

5.2.4.2 Post-Construction Effects

Post construction impacts associated with the rehabilitation of the dam are the same as those described in Section 5.2.3.2. In addition, it is anticipated that this operation of a fish elevator system on Ballville Dam, with the inclusion of a fish sorting facility to withhold invasive species, would have negligible adverse impacts (e.g., stress from handling, exposure to infectious diseases from crowding) to fisheries. However, positive impacts of this alternative on native species populations such as Walleye, White Bass, River Redhorse, Greater Redhorse, and Freshwater Drum may depend on the behavioral characteristics and the physiology of each fish species. We could find no published examples of fish elevators for a dam of equal size to

Ballville with a similar complement of species. At present it is uncertain how effective the fish elevator would be. While a fish elevator would provide increased access for some species, it is expected that this alternative would have limited benefit to fish migration in the Sandusky River because not all species can or would use an elevator. Fish community integrity would continue to be low in the impounded section due to degraded habitat, altered hydraulics, poor water quality, and reduced aquatic invertebrate production.

Fish elevator systems are not used for downstream fish passage, meaning that individuals moving downstream would either be stopped by Ballville Dam or pass over the spillway, increasing the likelihood of mortality. For migratory species, such as Walleye or White Bass, which successfully navigate the elevator system and reproduce upstream of the dam, it is expected that larval mortality would be high but it is not possible to quantify how high at this time. Causes of mortality would include physical trauma from hydraulic forces as well as blunt force impacts (e.g., rocks, concrete, etc.). Small fish passing over the dam would likely be disoriented and subject to predation from fish holding below the dam. It is known that adult Walleye planted in the upper watershed passed successfully over the dam and were recaptured in the lower river (Jeff Tyson, personal communication).

5.2.4.3 Mitigation Measures

Construction and maintenance of the facility would require a USACE Dept. of Army Permit (Section 404 Clean Water Act and Section 10 Rivers and Harbors Act) and State of Ohio Water Quality Certification by OEPA (Section 401 Clean Water Act). All terms and conditions would be followed to ensure minimal, if any, impacts to wildlife and fisheries.

Construction would be timed to avoid sensitive life history windows for key species in the project area (e.g., fish reproduction, bat roosting, etc.).

Sorting facilities would be operated in the migration period to prevent non-native aquatic species from passing upstream.

Maintenance operations would be completed during non-spawning seasons (mid-June to March). Maintenance is not expected to impact wildlife or fisheries.

5.2.5 Alternative 3 – Dam Removal with Ice Control Structure

5.2.5.1 Construction Effects

Alterations to the structural and functional elements of aquatic and terrestrial ecosystems from construction associated with Alternative 3 would be similar to those described in Section 5.2.2.1 for the Proposed Action. Alternative 3, however, is designed to construct the ICS and remove the dam in as short a time period as possible. Therefore, this alternative has the potential to impact aquatic species and habitat more severely than in the Proposed Action. In the Proposed Action, suspended solids would be elevated during construction phase and then concentrations would increase again when construction is resumed the following year. Under

Alternative 3, elevated concentrations would be continuous for the duration of construction and ultimately exceed expected concentrations compared to the Proposed Action with no seeding or bank stabilization phase included in Alternative 3. Alternative 3 would result in prolonged minor adverse impacts (e.g., disrupted foraging) to sediment intolerant species downstream as a larger pulse of sediment is released during construction. Some turbidity tolerant species such as Yellow Perch may realize a temporary competitive advantage over other species (Clayton and Morris 2009). Other visual sight feeders (e.g., kingfishers, blue herons) may also be temporarily affected.

The discharge of sediment, as a result of a single phase dam removal, into the downstream reach of the Sandusky River has the potential to increase sediment concentrations and impact aquatic habitat. In Alternative 3 all of the sediment upstream of the impoundment would be available for export immediately during and after demolition of the dam. This could lead to greater aggradation in the downstream reaches and shifts in substrate type to finer grained sediment. In most cases effects to aquatic organisms are within the natural range of variation for aquatic organisms in the Project Area (FEIS Appendix A11). However, Alternative 3 would likely increase the severity of disturbances to aquatic communities in comparison to the Proposed Action.

5.2.5.2 Post-Construction Effects

Long term post construction effects associated with Alternative 3 would be very similar to those described in Section 5.2.2.2. However, the magnitude of adverse effects on downstream aquatic biota associated with Alternative 3 would likely be greater in the near term due to the less controlled nature of the sediment release and single phased dam removal. It is expected that the duration of sediment export from the impoundment would be shorter in this scenario than in the Proposed Action. Therefore higher suspended sediment concentrations and more sediment aggradation would be expected in the downstream channel. Short term changes to habitat resulting from the sediment wedge would potentially degrade spawning habitat and reduce foraging efficiency for fish near term. Increased suspended sediment concentrations may cause physiological stress and alter some behaviors; however, concentrations are expected to fall well short of lethal levels. The primary difference between the Proposed Action and Alternative 3 is that, given equal stream flow patterns, the magnitude of sediment export in Alternative 3 would be higher. The notch in the Proposed Action is intended to minimize adverse impacts of this export to fish and other aquatic organisms although the benefits of this strategy are difficulty to quantify given the inherent variability of natural systems (i.e., stream flow patterns).

Similar to the Proposed Action, Alternative 3 would be expected to have a long-term beneficial effect on aquatic species by opening up 22 miles (35.4 kilometers) of Sandusky River habitat that was previously inaccessible due to the presence of the dam. Short-term, minor adverse effects to some localized aquatic species may occur due to sedimentation, but these effects would be minimized by mitigation measures, and would not persist for longer than a few years. Both Alternative 3 and the Proposed Action would provide an additional vector for the movement of aquatic invasive species in the Sandusky River, although it is impossible to know with certainty which species may attempt to utilize this vector or their rate of successful establishment.

5.2.5.3 Mitigation Measures

Existing roads would be used to the maximum extent practicable. Construction would be timed to avoid sensitive life history windows for key species in the project area (e.g., fish reproduction, bat roosting, etc.). Development of the north access road for access to the area below the dam would adhere to seasonal restrictions for tree clearing (October 1 to March 31) to avoid impacts to bats and birds either migrating or breeding. Additionally, these dates are the most likely to avoid impacts to other wildlife that could be present during other times of year.

For aquatic species, while continual removal of the dam occurs and the drawdown of the impoundment begins, native live mussels located on the exposed bars/margins of the former impoundment would be recovered and relocated to suitable habitat in the Sandusky River upstream of the dam as quickly as possible. This activity would be coordinated with resource agencies. Relocated mussels would be periodically monitored to determine survival rates, and a monitoring report would be provided to ODNR and the Service.

A pre- and post-project monitoring plan is in place for aquatic populations utilizing the lower Sandusky river relating to Alternative 3. Pre-project monitoring characterizing the current fish community in the area around the Ballville Dam, and to quantify migratory fish abundance has been completed (OEPA 2011a; Ross 2013). Fish assessment surveys will be completed periodically into the future to quantify potential responses in the fish community. Demolition for Alternative 3 would be sequenced to occur in the fall, just before the onset of the wet season. The timing of construction is important because it would avoid sediment releases during the low flow, warmer summer months when water quality impacts would be the greatest and when the river has the least capacity to move sediment. This strategy would minimize the potential for physiological stress and mortality in aquatic organisms by restricting demolition to periods when stream temperatures would be low and metabolic demand would also be low.

Lastly, Best Management Practices (BMPs) and acceptable design and construction procedures would be used to reduce or eliminate anticipated undesirable effects such as soil erosion, resulting from construction that could contribute to sediment deposition. Erosion control and stormwater management is required during construction through the National Pollutant Discharge Elimination System (NPDES) permitting program. Additionally, any work in the Sandusky River would require a USACE Dept. of Army Permit (Section 404 Clean Water Act and Section 10 Rivers and Harbors Act) and State of Ohio Water Quality Certification by OEPA (Section 401 Clean Water Act). All terms and conditions would be followed to ensure no significant impacts occur to wildlife and fisheries.

6.0 COMPARISON OF ALTERNATIVES

NEPA (40 CFR 1501) and Service guidelines (550 FW 2.6) require that an EIS include a discussion and comparison of the effects of the Proposed Action and alternatives, including reasonable mitigation measures identified during the EIS development. Chapter 3 of this Final SEIS describes the alternatives, and the resource-specific sections of Chapter 5 describe the effects and reasonable minimization, avoidance, and mitigation measures associated with the new information and re-analysis based on comments received. This chapter compares the impacts of the Proposed Action and alternatives and their potential mitigation measures

6.1 EFFECTS SUMMARY OF EIS

Four alternatives were carried forward for analysis in the FEIS as well as the Final SEIS: the Proposed Action – Incremental Dam Removal with Ice Control Structure, Alternative 1 – No Action, Alternative 2 – Fish Passage Structure, and Alternative 3 – Dam Removal with Ice Control Structure. Each Alternative is differentiated from one another by various methods of achieving the purpose and need of the project, resulting in different levels of success balanced with the impact of those actions. The Proposed Action meets all of the purposes and needs for the project while working to minimize sediment impacts downstream. The No Action Alternative would result in no significant change to the identified resources because the Dam would be rehabilitated and remain in place. Table 3-1 compares the anticipated impacts of the Proposed Action with Alternatives 1-3 as defined above and in Chapter 3. Specific impacts and mitigation measures that address some or all of those anticipated impacts are described in Chapter 5 of the FEIS and the Final SEIS and summarized in Table 6-2.

Table 6-1. Comparison of Anticipated Impacts for Each Alternative

Resource	Proposed Action – Incremental Dam Removal with Ice Control Structure	Alternative 1 – No Action	Alternative 2 – Fish Passage Structure	Alternative 3 – Dam Removal with Ice Control Structure
5.1 - Water Resources	Periodic sediment suspension within the water column during pool drawdown over 2 years; minor aggradation of sediment downstream; permanent improvements in water quality within the former dam pool reach; permanent improvements in natural riverine sediment transport processes. Placement of 28,000 CY of fill in and along approximately 866 linear feet of the Sandusky River, covering 4.38 acres for river bank shaping.	Temporary localized sedimentation for a short distance above and below the dam expected during rehabilitation and future sluice gate operations	Temporary localized sedimentation for a short distance above and below the dam expected during rehabilitation, fish passage construction, and future sluice gate operations	Periodic sediment suspension within the water column during the 10 month period; minor aggradation of sediment downstream; permanent improvements in water quality within the former dam pool reach; permanent improvements in natural riverine sediment transport processes. Placement of 28,000 CY of fill in and along approximately 866 linear feet of the Sandusky River, covering 4.38 acres for river bank shaping.

Table 6-1. Comparison of Anticipated Impacts for Each Alternative

Resource	Proposed Action – Incremental Dam Removal with Ice Control Structure	Alternative 1 – No Action	Alternative 2 – Fish Passage Structure	Alternative 3 – Dam Removal with Ice Control Structure
5.2 - Wildlife and Fisheries	Temporary displacement of fish and wildlife and habitat degradation during the 24 month construction time period and while impounded sediment is moved downstream; long term aquatic habitat improvements from the area returning to a free flowing river ecosystem are expected including reopening approximately 22 miles of aquatic habitat to migratory fish species; improved fish and aquatic invertebrate community upstream of the former dam	Temporary, minor displacement of fish and wildlife, and habitat degradation expected during rehabilitation and possibly during annual sluice gate operations, continued long term negative impact on species in the area from presence of the dam	Temporary, minor displacement of fish and wildlife, and habitat degradation expected during rehabilitation and possibly during annual sluice gate operations, likely continued long term negative impact on species in the area from presence of the dam; uncertain if fish passage structure would have benefits to some species	Temporary displacement of fish and wildlife and habitat degradation during the 10 month time period and while impounded sediment is moved downstream are expected to be more severe than the under the Proposed Action; long term aquatic habitat improvements from the area returning to a free flowing river ecosystem are expected including reopening approximately 22 miles of aquatic habitat to migratory fish species; improved fish and aquatic invertebrate community upstream of the former dam

Table 6-2. Mitigation Measures

Resource	Avoidance, Minimization, and Mitigation Measures
5.1 - Water Resources	Best Management Practices (BMPs) and acceptable design and construction procedures would be used to reduce or eliminate anticipated undesirable effects such as soil erosion, resulting from construction that could contribute to sediment deposition. Erosion control and storm water management is required during construction through the National Pollutant Discharge Elimination System (NPDES) permitting program.
	All terms and conditions of USACE and OEPA permits will be followed.
	Seeding the formerly inundated impoundment following the initial dam notch with native wetland vegetation would help stabilize the sediments and aid in minimizing erosion and sediment release to downstream aquatic habitats.
	Impacts to the lower Sandusky River and Lake Erie would be minimized through the timing of the demolition. Specifically, demolition activities expected to release sediment into the river would be carried out at the beginning of the wet season, anticipating sufficient flow rate to assist with sediment transport; and when ambient concentrations are already high to reduce the likelihood of an abrupt environmental change or shock to the lower river.
	Long term improvements to surface water quality from dam removal will result from the project and will be documented through increases in QHEI, fish IBI, and macroinvertebrate ICI scores and attainment of Aquatic Life Uses. These improvements will offset temporary impacts from increased sediment load.
5.2 - Wildlife and Fisheries	The incremental approach was designed to result in the release of smaller volumes of sediment over a longer time frame. This is expected to minimize the size of the sediment wedge and the magnitude of suspended sediment to minimize potential impacts to aquatic species inhabiting areas downstream of the dam.
	Demolition would be sequenced to occur in the fall, just before the onset of the wet season. This strategy would minimize the potential for physiological stress and mortality in aquatic organisms by restricting demolition to periods when stream temperatures would be low and metabolic demand would also be low.
	Colonization of upstream reaches by aquatic invasive species may take years or decades, post project aquatic resource monitoring would assist in understanding what species are moving through the area and utilizing the aquatic habitat.
	A pre- and post-project monitoring plan is in place for aquatic populations utilizing the lower Sandusky river.

6.2 SUMMARY OF IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversible commitment of resources refers to the loss, as a result of the Project, of future options for resource development or management, especially of nonrenewable resources such as minerals and cultural resources (40 CFR 1508.1 1). Irretrievable commitment of resources refers to the lost production or use value of renewable natural resources as a result of the Project (40 CFR 1508.1 1). The Proposed Action and Alternative 3 of the Ballville Dam Project involve the irreversible and irretrievable commitment of material resources, energy, and cultural and historical resources.

To date, no irreversible or irretrievable loss of resources associated with the Project has occurred. Further, the Service will not approve any proposal that would result in irreversible or irretrievable loss of resources prior to publication of the Supplemental ROD.

6.2.1 Irreversible and Irretrievable Commitment of Material Resources and Energy

Material resources used for the Project for all alternatives (Proposed Action, Alternative 1, Alternative 2, and Alternative 3) include building materials for temporary access roads, placement of temporary or permanent structures, and other elements described in Chapter 3. Construction of the Project would also require use of fossil fuels, a nonrenewable natural resource.

6.2.1.1 Proposed Action – Incremental Dam Removal with Ice Control Structures

Completion of the Proposed Action would result in an irreversible or irretrievable loss of some biological resources over the life of the Project, including the irretrievable loss of approximately 54 acres of current wetland habitat and 0.5 acres of forest habitat. As the project progresses, approximately 23-55 acres of new wetlands are expected form based on the restored river ecosystem in areas currently inundated by the impoundment. Additionally, the 0.5 acres of forested area would in part be seeded and returned to a natural state post construction, although would not be readily returned to forested area.

Additionally, the Removal of Ballville Dam would represent an irreversible and irretrievable loss of cultural and historic resources. This would be a permanent impact and a Programmatic Agreement has been written (FEIS Appendix D1) to guide the completion of mitigation efforts to accommodate this loss.

Lastly, in conjunction with the flood walls downstream, the Ballville Dam has been shown to aid in minimizing ice flooding risk for the City of Fremont and nearby residents. The removal of the dam would represent a loss of this function and possible increased risk of ice flooding. As such, the proposed removal of Ballville Dam includes plans to build an ICS, designed and intended to replace this function currently provided by Ballville Dam to maintain the safety of communities in the area. The ICS was constructed September through October of 2016 by the City under a separate 404 permit provided by USACE (See Section 3.1). The Service has worked closely with the City of Fremont on this component of the project to understand its relationship to the Ballville Dam Project as a whole however the Service was not involved with ICS permitting or installation.

6.2.1.2 Alternative 1 - No Action Alternative

The No Action Alternative would result in the irretrievable loss of items described in Section 6.2.1 including materials needed to rehabilitate the structure and maintain it.

6.2.1.3 Alternative 2 - Fish Passage Structure

The Fish Passage Alternative would result in the irretrievable loss of items described in Section 6.2.1 including materials needed to rehabilitate the structure and maintain it. In addition, materials needed to build the fish passage structure and maintain it would also be required.

6.2.1.4 Alternative 3 – Dam Removal with Ice Control Structures

The Dam Removal with Ice Control Structure Alternative would result in the same irreversible or irretrievable loss of resources as the Proposed Alternative.

6.3 IDENTIFICATION OF PREFERRED ALTERNATIVE

The "preferred alternative" is a preliminary indication of the federal responsible official's preference of action, which is chosen from among the Proposed Action and alternatives analyzed in an EIS. The preferred alternative may be selected for a variety of reasons (such as the priorities of the particular lead agency) in addition to the environmental considerations discussed in the EIS. The preferred alternative is not a final agency decision; rather, it is an indication of the agency's preference. The final agency decision will be presented in the Supplemental ROD after public comments have been received and considered within the SEIS process as appropriate.

In accordance with NEPA (40 CFR §1502.14(e)) and based on consideration of agency and public comments on the DEIS, FEIS, ROD, and Draft SEIS the Service has selected the Proposed Action – Incremental Dam removal with installation of ice control structure--as the preferred alternative. Of the alternatives evaluated in this Final SEIS, this alternative best fulfills the agency's statutory mission and responsibilities while meeting the purpose and need. The selection of the Proposed Action as the preferred alternative is based on the following:

1) Implementation of the Proposed Action would restore natural hydrological processes, re-open fish passage, restore flow conditions, and improve overall conditions for native fish communities in the Sandusky River system both upstream and downstream of the Ballville Dam, restoring self-sustaining fish resources.

2) Implementation of the Proposed Action would also eliminate flood risks to the City of Fremont; eliminate liabilities associated with the current safety conditions of the Ballville Dam, manage the downstream movement of stored impoundment sediments; and restore Aquatic Life Habitat Use-Attainment for the lower Sandusky River.

6.4 IDENTIFICATION OF ENVIRONMENTALLY PREFERRED ALTERNATIVE

The environmentally preferred alternative is the alternative that would promote the requirements expressed in section 101(b) of NEPA. It is the alternative that causes the least damage to the biological and physical environment and that best protects, preserves, and enhances historic, cultural, and natural resources (CEQ 1981, Q6a [48 Fed. Reg. 18027]). The environmentally preferred alternative has not been selected at this time. The Service will select an environmentally preferred alternative in the Supplemental ROD.

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